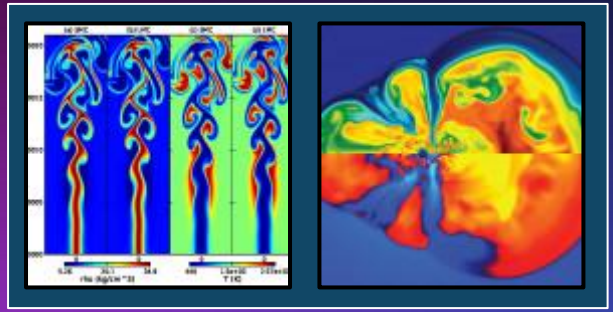
An Automated Approach to Continuous Acceptance Testing of HPC Systems at NERSC

HPCSYSPRO22 at SC22 Nov 14th, 2022



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Sameer Shende, University of Oregon
Wyatt Spear, University of Oregon
Prathmesh Sambrekar, Arizona State University
Sijie Xiang, Carnegie Mellon University

SC22 Dallas, TX | hpc accelerates.

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Our Software Testing and Integration Team

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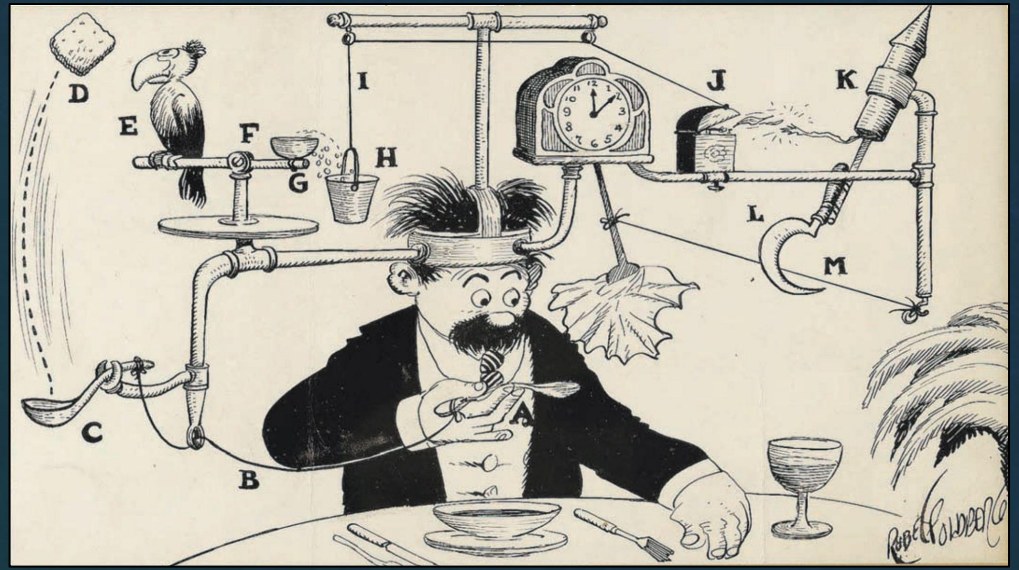
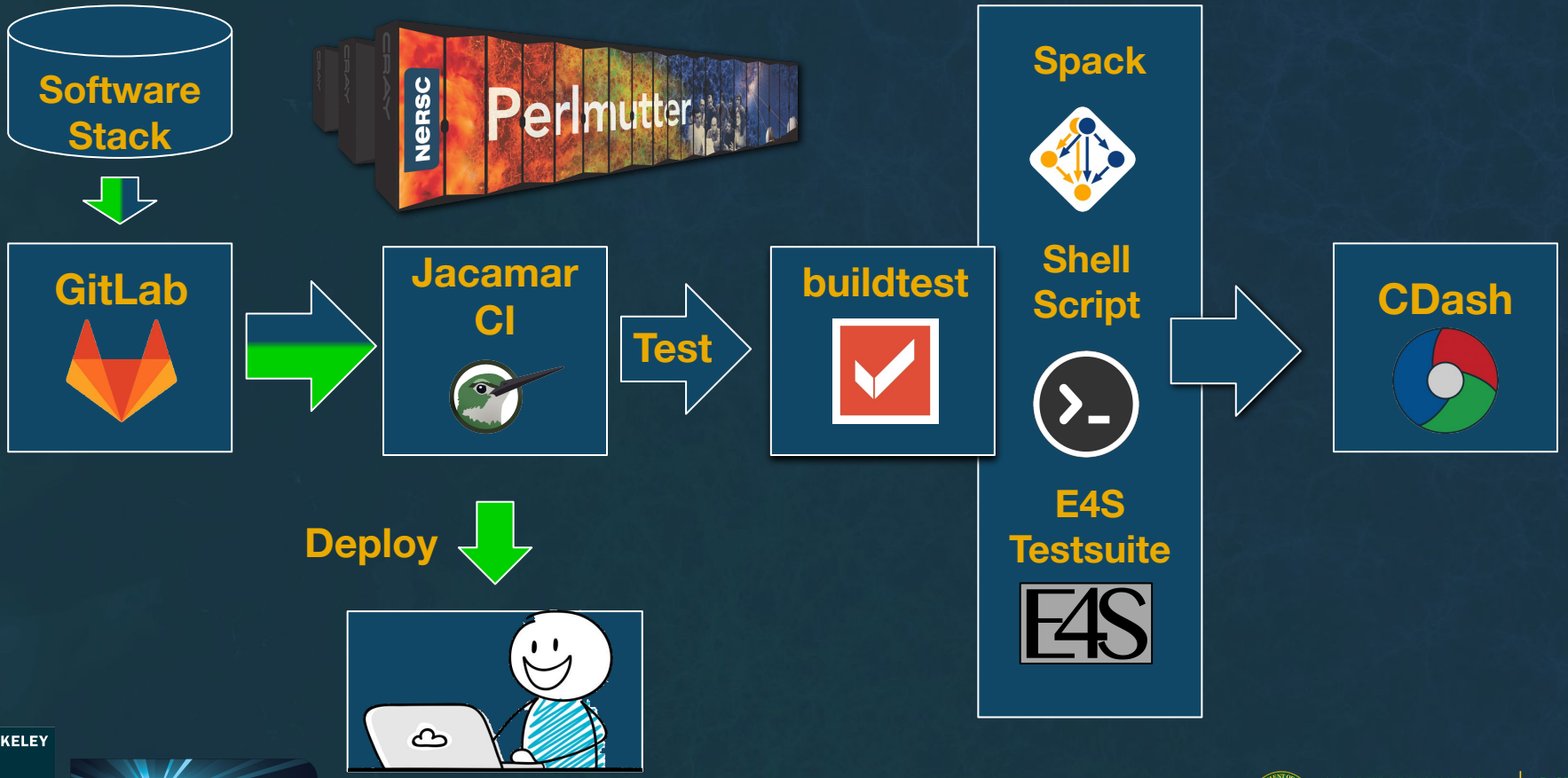
Wyatt Spear

Deploying Software in HPC can be Complex

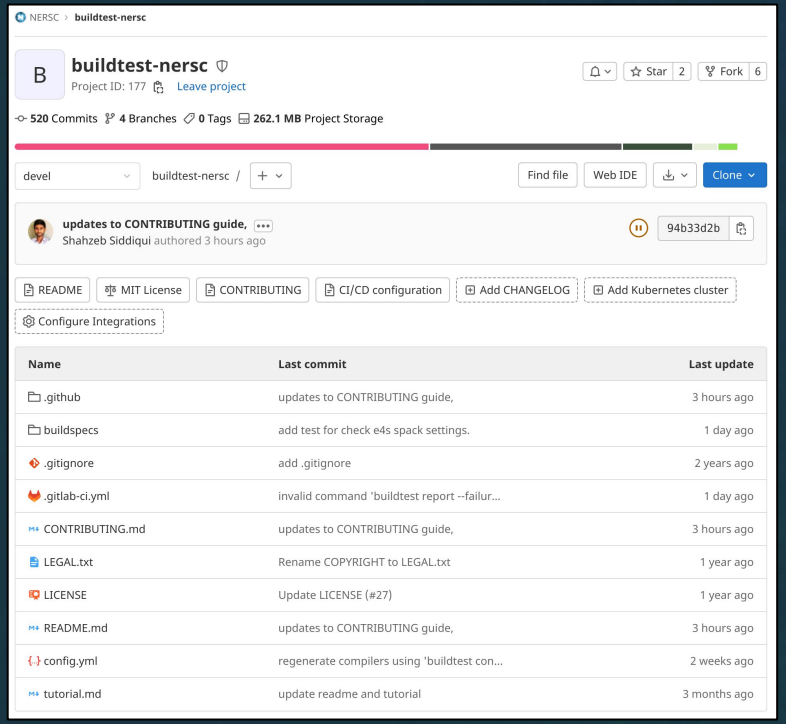
- Tight, complex dependencies between software packages in a stack, and the environment
- Wide range of software needed by a wide range of users
- Research software is often not written with “product” qualities



Workflow


Software Stack
NERSC
Perlmutter
Spack
GitLab
Jacamar CI
Test
buildtest
Shell Script
CDash
Deploy
E4S Testsuite
E4S

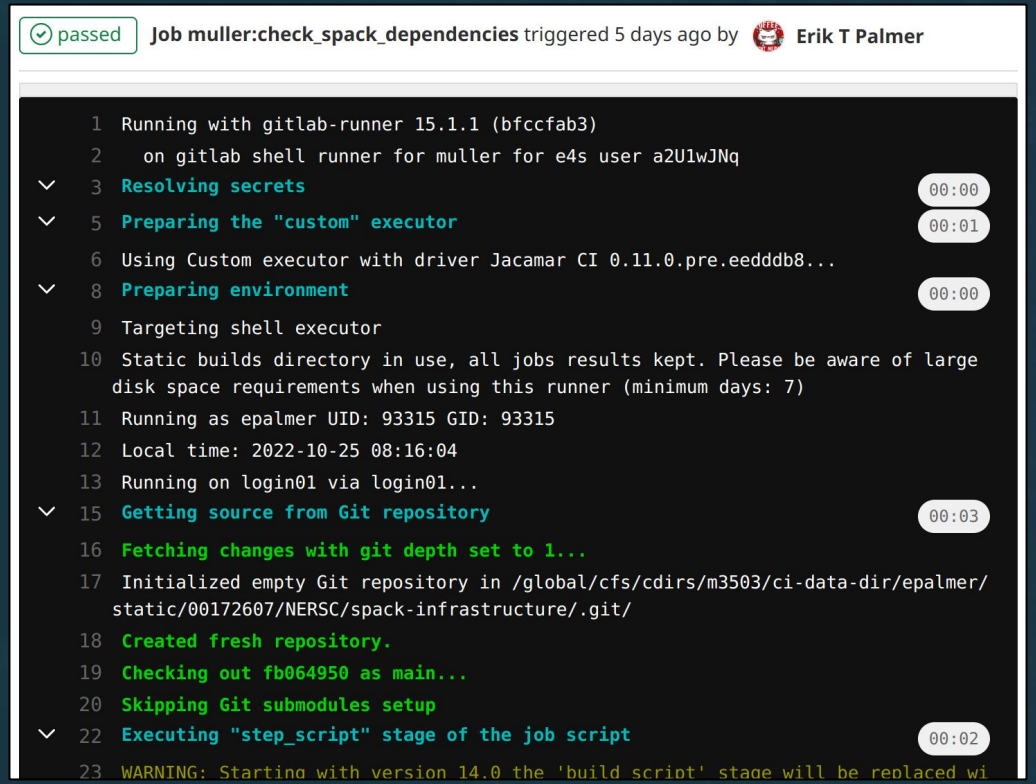
GitLab



- NERSC hosted GitLab CI/CD to develop and deploy our software stack
- Infrastructure and test development separated into two projects
- Pipelines initiated by merge and schedule
- GitLab runner runs as single user on a login node

Description	Target	Last Pipeline	Next Run	Owner	
Muller System Check	devel	#74628	in 14 hours	Shahzeb Siddiqui	Take ownership
Muller E4S Test	devel	#74630	in 16 hours	Shahzeb Siddiqui	Take ownership
Perlmutter GPU Check	devel	#74605	in 57 minutes	Shahzeb Siddiqui	Take ownership
Perlmutter System Check	devel	#74464	in 2 days	Shahzeb Siddiqui	Take ownership

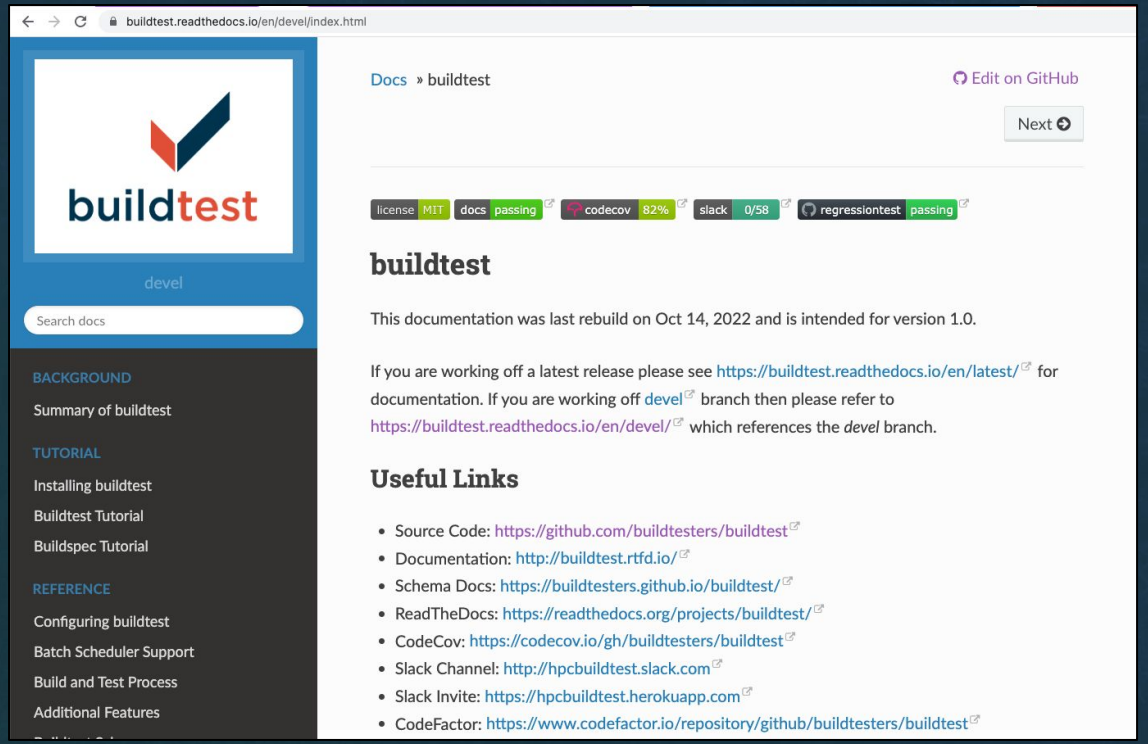
Jacamar CI



- Custom GitLab executor for HPC systems
- Provides a static directory structure for CI jobs to preserve previous job artifacts
- Integrates with batch schedulers
- Provides security features for HPC systems:
  - downscoping as a non-root user
  - server logs for job tracing

buildtest

- Buildtest is a testing framework for HPC systems
- Intended for HPC Staff, developers, end-users who want to test the HPC system
- Designed to:
  - Facilitate test creation
  - Automate test execution
  - Aggregate test results
- Tests are written declaratively in YAML known as **buildspecs** which buildtest will process into a shell script.
- Integration with several batch schedulers including LSF, Slurm, PBS and Cobalt



buildtest

Example buildtest test “buildspec”

```yaml
buildspecs:
  amrex_single_vortex:
    executor: '(perlmutter|muller).slurm.regular'
    type: script
    description: "AmrLevel SingleVortex Build and Run"
    tags: ["e4s"]
    sbatch:
      - "-A m[redacted]"
      - "-N 1"
      - "-t 00:05:00"
      - "-C gpu"
      # Note: This test doesn't use GPUs.
    run: |
      module load e4s/21.11-tcl

      # Use the PrgEnv-gnu to avoid issues with NVHPC and Fortran
      module load PrgEnv-gnu

      spack load cmake
      spack load amrex

      # Store AMReX install location
      export AMR_DIR=$(spack location -i amrex)

      cd test/Exec
      mkdir build
      cd build

      cmake .. \
      -DAMReX_FORTRAN=ON \
      -DAMReX_FORTRAN_INTERFACES=ON \
      -DAMReX_DIR=${AMR_DIR}/lib/cmake/AMReX \
      -DAMReX_SPACEDIM=3

      cmake --build . -j4
      srun -n 4 ./SingleVortex ../inputs max_step=1

    status:
      regex:
        stream: stdout
        exp: "finalized"
maintainers:
  - epalmer
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- Declarative YAML format
- Validated by buildtest

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- shell script:
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- shell script:
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- Flexible testing criteria:
  - regex of stdout

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```
[Level 2 step 20] Advanced 247868 cells
Coarse STEP 5 ends. TIME = 0.05475189088 DT = 0.01096740925
Writing plotfile plt00005

Total Time: 3.564830664
Unused ParmParse Variables:
  [TOP]::amr.do_tracers(nvals = 1)  :: [1]

AMReX (22.10) finalized
```

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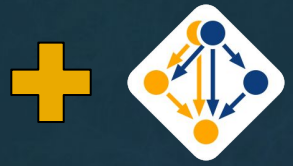


Spack

```
buildspecs:
  spack_test_amrex_e4s_22.05:
    type: spack
    executor: '(perlmutter|muller).local.sh'
    description: "Test AMReX for e4s/22.05 stack for Perlmutter via spack test"
    tags: e4s
    pre_cmds: |
      module swap PrgEnv-nvidia PrgEnv-gnu
      module load e4s/22.05
    spack:
      root: /global/common/software/spackecp/perlmutter/e4s-22.05/spack/
      verify_spack: false
      test:
        run:
          specs: ['amrex']
        results:
          option: '-l'
          specs: ['amrex']
```

- Spack is a package manager for supercomputers
- Used to deploy our software stack
- Spack supports stand-alone testing which buildtest can leverage

buildtest + E4S Testsuite

```yaml
#This buildtest was generated from e4s-template.yaml
buildspecs:
  hdf5_e4s_testsuite_22.05:
    type: script
    executor: perlmutter.slurm.regular
    description: Run E4S Testsuite hdf5 test for e4s/22.05 stack
    tags: [e4s]
    sbatch: ["-t 30", "-N 1", "-G 1", "-A [redacted]", "-C gpu"]
    run: |
      module load e4s/22.05
      spack load --first cmake
      git clone https://github.com/E4S-Project/testsuite
      cd testsuite

      sh test-all.sh --color-off validation_tests/hdf5 --print-logs
maintainers:
  - shahzebsiddiqui
  - wspear
```

- E4S Testsuite includes over 100 tests, with a goal of full test coverage for the E4S ecosystem
- Test code largely extracted from package sources
- Uses a simple, extensible bash-script test driver

CDash

5 passed, 3 failed, 0 not run, 3 missing.

Name	Status	Time	Details	Labels	History	Summary	compiler	description	endtime	hostname	starttime	user
e4s_hdf5	Failed	1h 46m 32s 940ms		e4s	Broken	Broken		Run hdf5 test from E4S Testsuite. This test is expected to fail	2022/10/18 08:50:44	cori02	2022/10/18 07:04:11	e4s
e4s_testsuite_e4s_22.02_gnu	Failed	2h 4m 6s 160ms		e4s	Broken	Broken		Run E4S Testsuite for e4s/22.02, gnu stack	2022/10/18 09:08:17	cori02	2022/10/18 07:04:11	e4s
e4s_testsuite_e4s_22.02_intel	Failed	2h 4m 36s 360ms		e4s	Broken	Broken		Run E4S Testsuite for e4s/22.02, intel stack	2022/10/18 09:08:47	cori02	2022/10/18 07:04:11	e4s
ascent_e4stestsuite_e4s_21.05	Missing											
e4s_adios2	Missing											
e4s_superlu-dist	Missing											
e4s_22_02_spack	Passed	6s 660ms		e4s spack	Unstable	Stable		Check e4s/21.05 spack instance	2022/10/18 07:04:17	cori02	2022/10/18 07:04:11	e4s
showquota	Passed	2s 170ms			Stable	Stable		run the showquota utility	2022/10/18 07:04:13	cori02	2022/10/18 07:04:11	e4s
showquota_check_m3503	Passed	830ms		e4s	Stable	Stable		run the showquota check on m3503 project directory	2022/10/18 07:04:12	cori02	2022/10/18 07:04:11	e4s
showquota_check_spackecp	Passed	680ms		e4s	Stable	Stable		run showquota on /global/common/software/spackecp	2022/10/18 07:04:11	cori02	2022/10/18 07:04:11	e4s
spack_e4s_directory_checks	Passed	80ms		e4s	Stable	Stable		Check for production directory paths for spack e4s stack	2022/10/18 07:04:11	cori02	2022/10/18 07:04:11	e4s

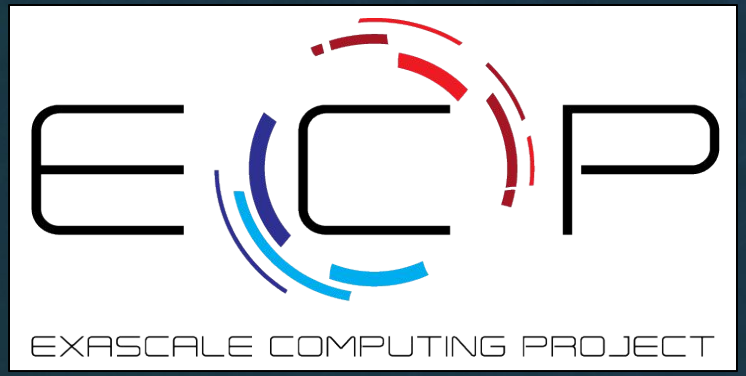
- Buildtest can upload results into CDash
- CDash produces color coded charts, timelines (track progress over time), and links to test output
- Comprehensible presentation of test results posted to the web for users and developers

Why do we test?

- Detect bugs in an environment as close to our user experience as possible
- Tests and results are publicly available and digestible for non-experts

Increase confidence in our system

Acknowledgements



This research was supported by the Exascale Computing Project (17-SC-20-SC), a joint project of the U.S. Department of Energy's Office of Science and National Nuclear Security Administration, responsible for delivering a capable exascale ecosystem, including software, applications, and hardware technology, to support the nation's exascale computing imperative.

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References

Buildtest

- Documentation: https://buildtest.rtfd.io/
- Source Code: https://github.com/buildtesters/buildtest
- Slack: http://hpcbuildtest.slack.com/
- Buildtest at NERSC: https://github.com/buildtesters/buildtest-nersc
- CDASH for buildtest-nersc: https://my.cdash.org/index.php?project=buildtest-nersc

E4S

- E4S Home Page: https://e4s.io
- E4S Docs: https://e4s.rtfd.io/
- E4S Testsuite: https://github.com/E4S-Project/testsuite

Spack

- Documentation https://spack.rtfd.io
- Source Code: https://github.com/spack/spack

GitLab

- GitLab Runner Docs: https://docs.gitlab.com/runner/
- GitLab CI/CD: https://docs.gitlab.com/ee/ci/

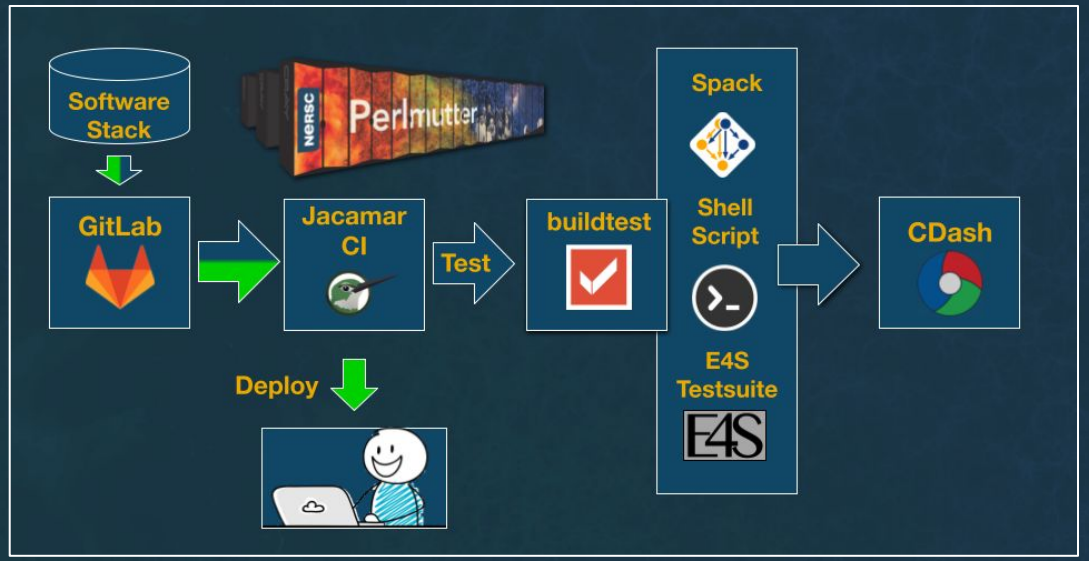
Jacamar CI

- Documentation: https://ecp-ci.gitlab.io/
- Source Code: https://gitlab.com/ecp-ci/jacamar-ci

Thanks for listening!

Key Points:

- Automated pipeline to build, test, and deploy a scientific software stack
- Jacamar CI and buildtest, bridge the gap between GitLab and our HPC systems with several unique features.
- Tests and test results are easily accessible and digestible by users to increase system confidence.



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