Buildtest: HPC Software Stack Testing Framework

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GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io

Motivation

- Framework Requirements:
  - The framework is capable of testing of installed software in HPC Software Stack
  - The framework is able to integrate with module system
  - The framework provides users with a markup language for writing tests
  - The framework is able to automate test creation and execution
  - The framework provides a test repository that is community driven
- Buildtest is not meant to replace tools like make, cmake, or autoconf

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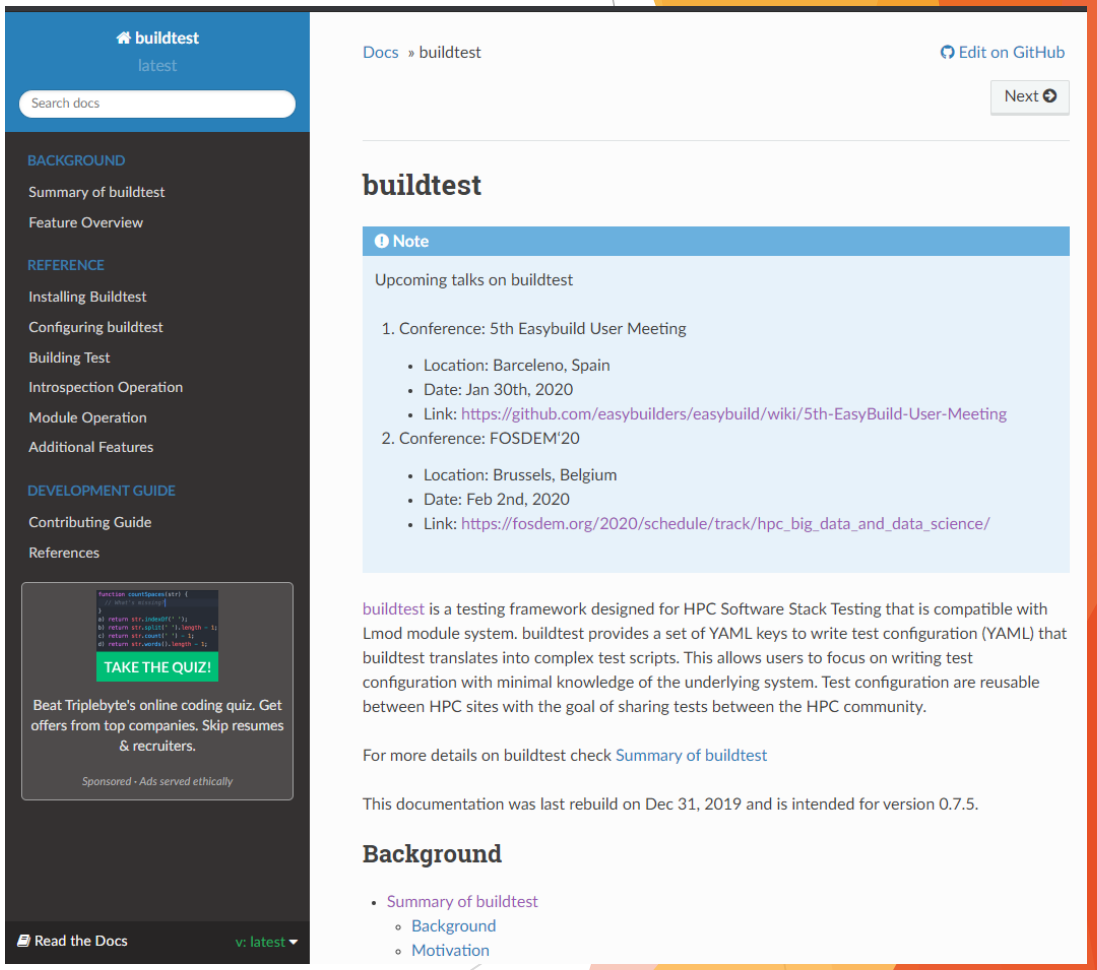
What is buildtest

- Buildtest is a framework that:
  - Automates test script creation
  - Abstracts test complexity by using test configuration written in YAML
  - Allows Portable test configurations
  - Provides many module operations
- Buildtest comes with a repository of test configuration and source files



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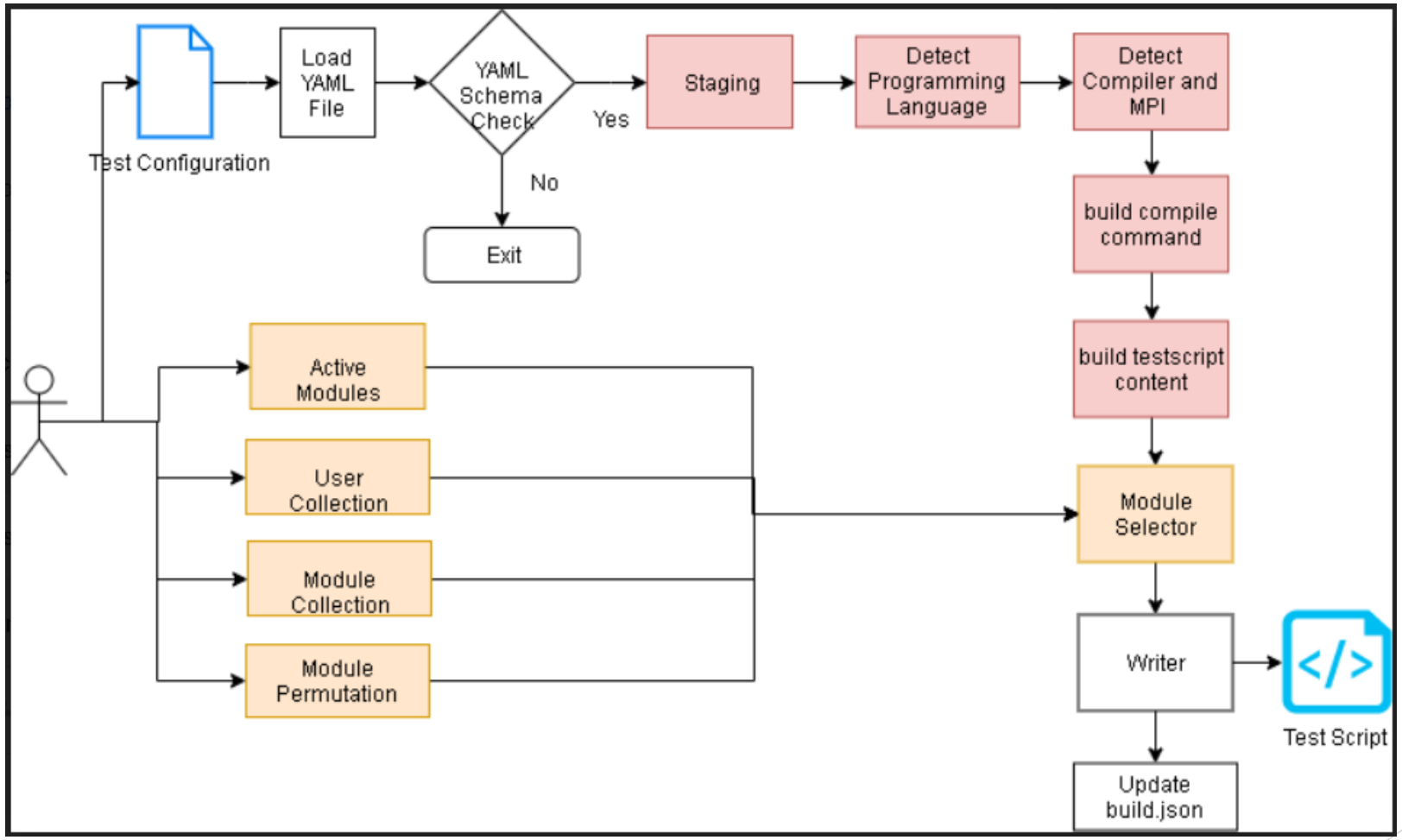
Build Pipeline



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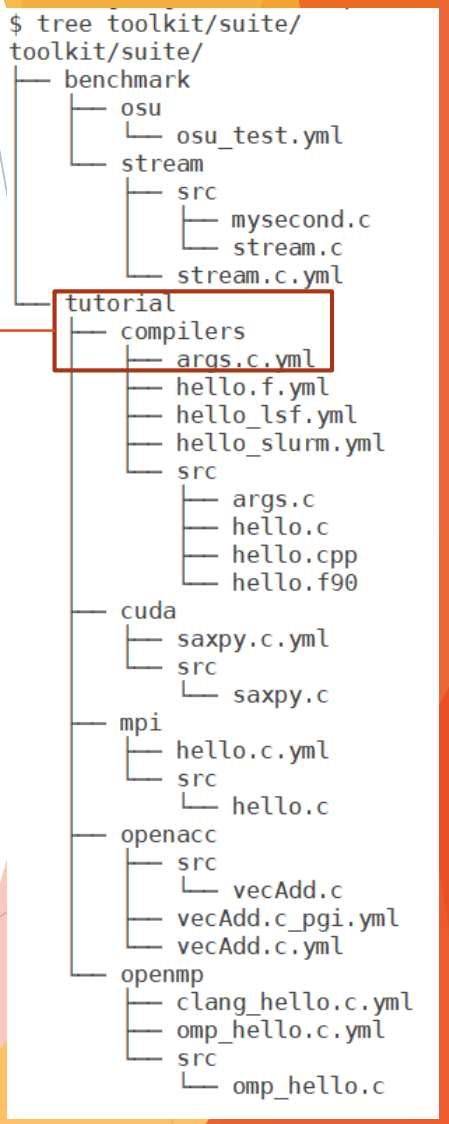
Building a Test

- To build a test script just specify a test configuration to buildtest as follows: buildtest build -c <test-configuration>
- The test configuration can be found under $BUILDTEST_ROOT/toolkit/suite
- Name of test configuration is formulated by replacing file separator (/) by a dot (.) so tutorial/compilers/args.c.yml → tutorial.compilers.args.c.yml
- Source code must be under src directory and test configuration must be named with extension .yml



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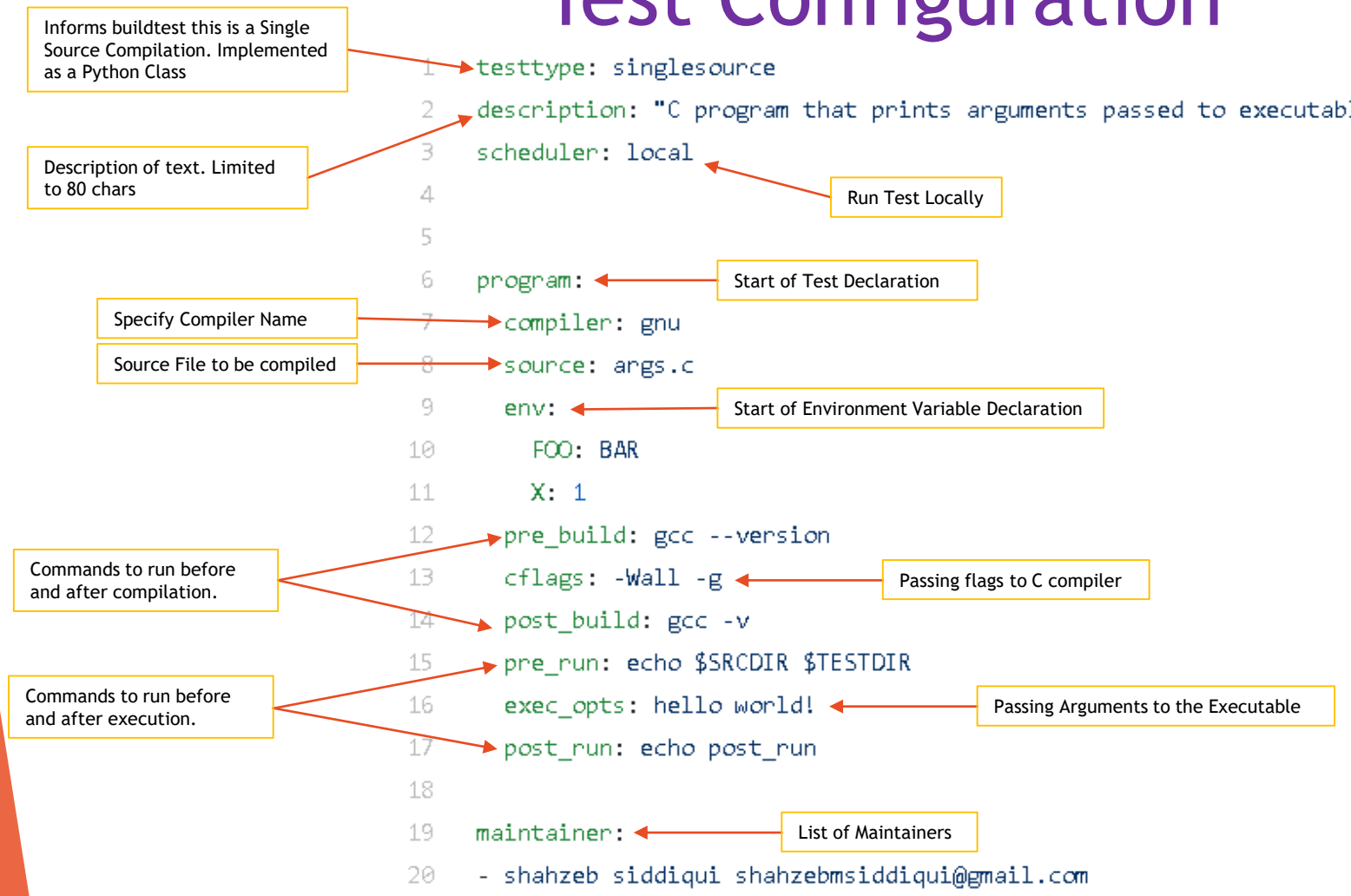
Test Configuration



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Language, Compiler and MPI Detection

Langage Mapping

Langage	File Extension
c	.c
c++	.cc .cxx .cpp .c++ .C
fortran	.f90 .f95 .f03 .f .F .F90 .FPP .FOR .FTN .for .ftn
cuda	.cu

Compiler Mapping

compiler	language=c	language=c++	language=fortran
gnu	gcc	g++	gfortran
intel	icc	icpc	ifort
pgi	pgcc	pgc++	pgfortran
clang	clang	clang++	N/A
cuda	nvcc	nvcc	N/A

MPI Flavor Mapping

MPI Flavor	language=c	language=c++	language=fortran
openmpi	mpicc	mpicxx	mpif90
intelmpi	mpiicc	mpiicpc	mpiifort
mpich	mpicc	mpicxx	mpif90

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Intel Example

```yaml
testtype: singlesource
description: Hello World Fortran example using GNU compiler
scheduler: local

program:
  source: hello.f90
  compiler: intel
  fflags: -O2

maintainer:
- shahzeb siddiqui shahzebmsiddiqui@gmail.com
```

```
$ buildtest build -c tutorial.compilers.hello.f.yml -co intel --dry
Loading Test Configuration (YAML) file: /u/users/ssi29/gpfs/buildtest-framework/toolkit/suite/tutorial/compilers/hello.f.yml
Checking schema of YAML file
Schema Check Passed
Scheduler: local
Source Directory: /u/users/ssi29/gpfs/buildtest-framework/toolkit/suite/tutorial/compilers/src
Source File: hello.f90
Detecting Programming Language, Compiler and MPI wrapper
Programming Language: fortran
FC: ifort
FFLAGS: -O2
Test:/tmp/ssi29/buildtest/tests/Intel/Haswell/x86_64/rhel/7.6/build_0/hello.f.yml.0x28f38c1.sh
--------------------------------------------------------------------------------

module purge
module restore intel
TESTDIR=/tmp/ssi29/buildtest/tests/Intel/Haswell/x86_64/rhel/7.6/build_0
SRCDIR=/u/users/ssi29/gpfs/buildtest-framework/toolkit/suite/tutorial/compilers/src
SRCFILE=$SRCDIR/hello.f90
FC=ifort
FFLAGS="-O2"
EXECUTABLE=hello.f.yml.0xa7f9d0b4.exe

cd $TESTDIR
$FC $FFLAGS -o $EXECUTABLE $SRCFILE
$EXECUTABLE
rm ./$EXECUTABLE
--------------------------------------------------------------------------------
```

PGI Example

- The vecAdd.c program is an OpenACC vector addition program that requires linking to math library (-lm)

```
testtype: singlesource
scheduler: local
description: OpenACC Vector Addition example using GNU compiler
maintainer:
- shahzeb siddiqui shahzebmsiddiqui@gmail.com

program:
  cflags: -acc
  compiler: pgi
  ldflags: -lm
  source: vecAdd.c
```

```
$ buildtest build -c tutorial.openacc.vecAdd.c_pgi.yml -co pgi --dry
Loading Test Configuration (YAML) file: /u/users/ssi29/gpfs/buildtest-framework/toolkit/suite/tutorial/openacc/vec
Checking schema of YAML file
Schema Check Passed
Scheduler: local
Source Directory: /u/users/ssi29/gpfs/buildtest-framework/toolkit/suite/tutorial/openacc/src
Source File: vecAdd.c
Detecting Programming Language, Compiler and MPI wrapper
Programming Language: c
CC: pgcc
CFLAGS: -acc
Test:/tmp/ssi29/buildtest/tests/Intel/Haswell/x86_64/rhel/7.6/build_1/vecAdd.c_pgi.yml.0x20567ea.sh
--------------------------------------------------------------------------------

module purge
module restore pgi
TESTDIR=/tmp/ssi29/buildtest/tests/Intel/Haswell/x86_64/rhel/7.6/build_1
SRCDIR=/u/users/ssi29/gpfs/buildtest-framework/toolkit/suite/tutorial/openacc/src
SRCFILE=$SRCDIR/vecAdd.c
CC=pgcc
CFLAGS="-acc"
LDFLAGS="-lm"
EXECUTABLE=vecAdd.c_pgi.yml.0x53d8036c.exe

cd $TESTDIR
$CC $CFLAGS -o $EXECUTABLE $SRCFILE $LDFLAGS
$EXECUTABLE
rm ./$EXECUTABLE
--------------------------------------------------------------------------------
```

Clang Example

```
testtype: singlesource
description: "OpenMP Hello World example in C with clang compiler"
scheduler: local
program:
  compiler: clang
  source: omp_hello.c
  cflags: -fopenmp
  pre_exec: OMP_NUM_THREADS=2
maintainer:
- shahzeb siddiqui shahzebmsiddiqui@gmail.com
```

```
$ buildtest build -c tutorial.openmp.clang_hello.c.yml -co Clang --dry
Loading Test Configuration (YAML) file: /u/users/ssi29/gpfs/buildtest-framework/toolkit/suite/tutorial/openmp/clang_hello.c.
Checking schema of YAML file
Schema Check Passed
Scheduler: local
Source Directory: /u/users/ssi29/gpfs/buildtest-framework/toolkit/suite/tutorial/openmp/src
Source File: omp_hello.c
Detecting Programming Language, Compiler and MPI wrapper
Programming Language: c
CC: clang
CFLAGS: -fopenmp
Test:/tmp/ssi29/buildtest/tests/Intel/Haswell/x86_64/rhel/7.6/build_1/clang_hello.c.yml.0x818b7343.sh
--------------------------------------------------------------------------------

module purge
module restore Clang
TESTDIR=/tmp/ssi29/buildtest/tests/Intel/Haswell/x86_64/rhel/7.6/build_1
SRCDIR=/u/users/ssi29/gpfs/buildtest-framework/toolkit/suite/tutorial/openmp/src
SRCFILE=$SRCDIR/omp_hello.c
CC=clang
CFLAGS="-fopenmp"
EXECUTABLE=clang_hello.c.yml.0x23a068cc.exe

cd $TESTDIR
$CC $CFLAGS -o $EXECUTABLE $SRCFILE
OMP_NUM_THREADS=2 $EXECUTABLE
rm ./$EXECUTABLE
--------------------------------------------------------------------------------
```

Build History

- Buildtest keeps track of every build in a json file (build.json). The **build ID** that can be used to retrieve tests, logs, and run tests
- To retrieve a report of all builds: **buildtest build report**

```
$ buildtest build report
ID   | Build Time           | Number of Tests | Command
-------------------------------------------------------------------------------------------
  0  | 10/20/2019 10:31:30  | 1               | buildtest build -c compilers.helloworld.hello_args.c.yml
  1  | 10/20/2019 10:31:39  | 8               | buildtest build -p gcc
  2  | 10/20/2019 10:31:54  | 1               | buildtest build -c openmp.reduction.omp_reduction.c.yml
  3  | 10/20/2019 10:32:04  | 5               | buildtest build -c openmp.hello.omp_hello.c.yml -m GCC
```

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Running Test Locally

- Running **buildtest build run <ID>** will run all test scripts that corresponds to the build ID.
- Buildtest will write a .run file that contains output of all tests
- A zero exit status will be a PASSED test and non-zero will be a FAILED test

```
$ buildtest build run 2
Running All Tests from Test Directory: /tmp/ssi29/buildtest/tests/Intel/Haswell/x86_64/rhel/7.6/build_2
================================================================
                        Test summary
Executed 5 tests
Passed Tests: 5 Percentage: 100.0%
Failed Tests: 0 Percentage: 0.0%
SUCCESS: Threshold of 100.0% was achieved
Writing results to /tmp/ssi29/buildtest/tests/Intel/Haswell/x86_64/rhel/7.6/build_2/run/buildtest_09_04_08_11_2019.run
```

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Integration with Spider

- Buildtest solves the module load problem by parsing json content by executing: spider -o spider-json $BUILDTEST_MODULEPATH
- Buildtest leverages spider to load modules into test.
- Spider is automatically updated when MODULEPATH changes!
- For more details on spider refer to the documentation: https://lmod.readthedocs.io/en/latest/136_spider.html

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Spider Content


```
"Anaconda3": {
    "/mxg-hpc/users/ssi29/easybuild/modules/all/Anaconda3/5.3.0.lua": {
        "Description": "Built to complement the rich, open source Python
platform \nthat empowers companies to adopt a modern open data science ana
        "URL": "https://www.anaconda.com",
        "Version": "5.3.0",
        "fullName": "Anaconda3/5.3.0",
        "help": "\nDescription\n===========\nBuilt to complement the rich
eady data analytics platform \nthat empowers companies to adopt a modern
===\n - Homepage: https://www.anaconda.com\n",
        "hidden": false,
        "lpathA": {
            "/mxg-hpc/users/ssi29/easybuild/software/Anaconda3/5.3.0/lib
        },
        "pV": "000000005.000000003.*zfinal",
        "pathA": {
            "/mxg-hpc/users/ssi29/easybuild/software/Anaconda3/5.3.0": 1
            "/mxg-hpc/users/ssi29/easybuild/software/Anaconda3/5.3.0/bin
        },
        "wV": "000000005.000000003.*zfinal",
        "whatis": [
            "Description: Built to complement the rich, open source Pyth
s platform \nthat empowers companies to adopt a modern open data science
            "Homepage: https://www.anaconda.com",
            "URL: https://www.anaconda.com"
        ]
    }
},
```


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Reporting Modules

- Buildtest will retrieve spider record from Lmod and present full canonical module name and path to module file.
- Buildtest will retrieve modules from all trees defined by **BUILDTEST_MODULEPATH**
- The default configuration for **buildtest module list** is defined as follows:

```
module:
  list:
    exclude_version_files: true
    filter:
      include: []
    querylimit: -1
```

```
$ buildtest module list

    Full Module Name                        |      ModuleFile Path
--------------------------------------------|---------------------------
xdusage/2.0                                 |      /opt/apps/xsede/modulefiles/xdusage/2.0
xdusage/2.1                                 |      /opt/apps/xsede/modulefiles/xdusage/2.1
gateway-usage-reporting/2.0                 |      /opt/apps/xsede/modulefiles/gateway-usage-reporting/2.0
cue-math                                    |      /opt/apps/xsede/modulefiles/cue-math
teragrid-basic                              |      /opt/apps/xsede/modulefiles/teragrid-basic
TERAGRID-DEV                                |      /opt/apps/xsede/modulefiles/TERAGRID-DEV
uberftp/2.8                                 |      /opt/apps/xsede/modulefiles/uberftp/2.8
cue-comm                                    |      /opt/apps/xsede/modulefiles/cue-comm
teragrid-dev                                |      /opt/apps/xsede/modulefiles/teragrid-dev
gsissh/7.1p2                                |      /opt/apps/xsede/modulefiles/gsissh/7.1p2
cue-login-env                               |      /opt/apps/xsede/modulefiles/cue-login-env
globus-6.0                                  |      /opt/apps/xsede/modulefiles/globus-6.0
globus/6.0                                  |      /opt/apps/xsede/modulefiles/globus/6.0
cue-tg                                      |      /opt/apps/xsede/modulefiles/cue-tg
xdinfo/1.3-1                                |      /opt/apps/xsede/modulefiles/xdinfo/1.3-1
TERAGRID-BASIC                              |      /opt/apps/xsede/modulefiles/TERAGRID-BASIC
GLOBUS-6.0                                  |      /opt/apps/xsede/modulefiles/GLOBUS-6.0
xdresourceid/1.0                            |      /opt/apps/xsede/modulefiles/xdresourceid/1.0
TERAGRID-paths                              |      /opt/apps/xsede/modulefiles/TERAGRID-paths
cue-build                                   |      /opt/apps/xsede/modulefiles/cue-build
CTSSV4                                      |      /opt/apps/xsede/modulefiles/CTSSV4
ctssv4                                      |      /opt/apps/xsede/modulefiles/ctssv4


Total Software Modules: 22
Total LUA Modules: 0
Total non LUA Modules: 22
```

- exclude_version_files: true will ignore **.version**, **.modulerc**, and **.modulerc.lua**
- querylimit: -1 Controls number of entries to print. A negative or 0 will print all entries
- include: [] filter output by list of module full canonical name

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Reporting Filtered Modules

- In order to filter modules **GCC, Python, zlib.** You can specify this in buildtest configuration **(settings.yml)** or via command line option **--filter-include**

```
module:
  list:
    filter:
      include: [GCC, Python, zlib]
```

```
$ buildtest module list --filter-include "GCC" "Python" "zlib"

    Full Module Name                        |      ModuleFile Path
--------------------------------------------|-----------------------------
GCC/6.4.0-2.28                              |      /mxg-hpc/users/ssi29/easybuild/modules/all/GCC/6.4.0-2.28.lua
GCC/7.1.0-2.28                              |      /mxg-hpc/users/ssi29/easybuild/modules/all/GCC/7.1.0-2.28.lua
GCC/9.2.0-2.32                              |      /mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/GCC/9.2.0-2.32.lua
GCC/8.1.0-2.30                              |      /mxg-hpc/users/ssi29/easybuild/modules/all/GCC/8.1.0-2.30.lua
GCC/8.1.0-2.30                              |      /mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/GCC/8.1.0-2.30.lua
GCC/8.3.0                                   |      /mxg-hpc/users/ssi29/easybuild/modules/all/GCC/8.3.0.lua
GCC/7.4.0-2.31.1                            |      /mxg-hpc/users/ssi29/easybuild/modules/all/GCC/7.4.0-2.31.1.lua
Python/3.7.4-GCCcore-8.3.0                  |      /mxg-hpc/users/ssi29/easybuild/modules/all/Python/3.7.4-GCCcore-8.3.0.lua
Python/2.7.14-GCCcore-6.4.0-bare            |      /mxg-hpc/users/ssi29/easybuild/modules/all/Python/2.7.14-GCCcore-6.4.0-bare.lua
zlib/1.2.11                                 |      /mxg-hpc/users/ssi29/easybuild/modules/all/zlib/1.2.11.lua
zlib/1.2.11-GCCcore-7.1.0                   |      /mxg-hpc/users/ssi29/easybuild/modules/all/zlib/1.2.11-GCCcore-7.1.0.lua
zlib/1.2.11-GCCcore-8.3.0                   |      /mxg-hpc/users/ssi29/easybuild/modules/all/zlib/1.2.11-GCCcore-8.3.0.lua
zlib/1.2.11                                 |      /mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/zlib/1.2.11.lua
zlib/1.2.11-GCCcore-7.4.0                   |      /mxg-hpc/users/ssi29/easybuild/modules/all/zlib/1.2.11-GCCcore-7.4.0.lua
zlib/1.2.11-GCCcore-6.4.0                   |      /mxg-hpc/users/ssi29/easybuild/modules/all/zlib/1.2.11-GCCcore-6.4.0.lua
zlib/1.2.11-zolwez4                         |      /mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/zlib/1.2.11-zolwez4.lua
zlib/1.2.11-GCCcore-8.1.0                   |      /mxg-hpc/users/ssi29/easybuild/modules/all/zlib/1.2.11-GCCcore-8.1.0.lua


Total Software Modules: 17
Total LUA Modules: 17
Total non LUA Modules: 0
```

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Buildtest Setting

- Buildtest configuration file is stored in $HOME/.buildtest/settings.yml
- The configuration is automatically placed if not found or deleted accidently.
- To view or edit the configuration file you can run: buildtest config view or buildtest config edit
- To learn more see how to Configure buildtest at https://buildtest.readthedocs.io/en/latest/configuring_buildtest.html

```
$ buildtest config view
BUILDTEST_MODULEPATH: []
BUILDTEST_MODULE_FORCE_PURGE: false
BUILDTEST_SPIDER_VIEW: current
BUILDTEST_SUCCESS_THRESHOLD: 1.0
BUILDTEST_TESTDIR: /tmp/$USER/buildtest/tests
EDITOR: vim
module:
  list:
    exclude_version_files: true
    filter:
      include: []
    querylimit: -1
  loadtest:
    login: false
    numtest: -1
    purge modules: true
```

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Buildtest Setting

- buildtest can report the configuration settings by running buildtest show –config

```
$ buildtest show --config
BUILDTEST_CONFIGS_REPO                                = /u/users/ssi29/gpfs/buildtest-framework/toolkit/suite
BUILDTEST_MODULEPATH                                  = /mxg-hpc/users/ssi29/easybuild/modules/all:/etc/modulefiles
:/usr/share/modulefiles:/usr/share/lmod/lmod/modulefiles/Core
BUILDTEST_MODULE_FORCE_PURGE                          = False
BUILDTEST_SPIDER_VIEW                                 = current
BUILDTEST_SUCCESS_THRESHOLD                           = 1.0
BUILDTEST_TESTDIR                                     = /tmp/ssi29/buildtest/tests
EDITOR                                                = vim
module-list-exclude_version_files                     = True
module-list-filter                                    = {'include': []}
module-list-querylimit                                = -1
module-loadtest-login                                 = False
module-loadtest-numtest                               = -1
module-loadtest-purge_modules                         = True
```

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Stampede2 Use Case (1/3)

- **Use Case: User wants to find all modules built for intel/18.**

1. User can set root of module tree which will update BUILDTEST_MODULEPATH.

```
(buildtest-framework) login1(997)$ buildtest module tree -s /opt/apps/intel18/modulefiles
Setting module tree: /opt/apps/intel18/modulefiles
Configuration File: /home1/06908/sms1990/.buildtest/settings.yml has been updated
```

2. User can view list of module trees

```
(buildtest-framework) login1(998)$ buildtest module tree -l
/opt/apps/intel18/modulefiles
```

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Stampede2 Use Case (2/3)

- Same output you would see when running **module av**
- Buildtest will report all modules in tree /opt/apps/intel/18/modulefiles

```
(buildtest-framework) login1(999)$ buildtest module list

    Full Module Name                        |      ModuleFile Path
--------------------------------------------|---------------------------
mvapich2/2.3                                |      /opt/apps/intel18/modulefiles/mvapich2/2.3.lua
mvapich2/2.3.1                              |      /opt/apps/intel18/modulefiles/mvapich2/2.3.1.lua
boost/1.68                                  |      /opt/apps/intel18/modulefiles/boost/1.68.lua
boost/1.65                                  |      /opt/apps/intel18/modulefiles/boost/1.65.lua
metis/5.0.2                                 |      /opt/apps/intel18/modulefiles/metis/5.0.2.lua
netcdf/4.6.2                                |      /opt/apps/intel18/modulefiles/netcdf/4.6.2.lua
netcdf/4.3.3.1                              |      /opt/apps/intel18/modulefiles/netcdf/4.3.3.1.lua
basemap/1.1.0                               |      /opt/apps/intel18/modulefiles/basemap/1.1.0.lua
eigen/3.3.4                                 |      /opt/apps/intel18/modulefiles/eigen/3.3.4.lua
pybind11/2.2.3                              |      /opt/apps/intel18/modulefiles/pybind11/2.2.3.lua
pdtoolkit/3.25                              |      /opt/apps/intel18/modulefiles/pdtoolkit/3.25.lua
gsl/2.3                                     |      /opt/apps/intel18/modulefiles/gsl/2.3.lua
trng/4.21                                   |      /opt/apps/intel18/modulefiles/trng/4.21.lua
hdf5/1.8.16                                 |      /opt/apps/intel18/modulefiles/hdf5/1.8.16.lua
hdf5/1.10.4                                 |      /opt/apps/intel18/modulefiles/hdf5/1.10.4.lua
nco/4.6.9                                   |      /opt/apps/intel18/modulefiles/nco/4.6.9.lua
canu/1.8                                    |      /opt/apps/intel18/modulefiles/canu/1.8.lua
superlu_seq/5.2.1                           |      /opt/apps/intel18/modulefiles/superlu_seq/5.2.1.lua
silo/4.10.2                                 |      /opt/apps/intel18/modulefiles/silo/4.10.2.lua
blis/git20180904                            |      /opt/apps/intel18/modulefiles/blis/git20180904.lua
blis/0.5.0                                  |      /opt/apps/intel18/modulefiles/blis/0.5.0.lua
udunits/2.2.25                              |      /opt/apps/intel18/modulefiles/udunits/2.2.25.lua
python3/3.7.0                               |      /opt/apps/intel18/modulefiles/python3/3.7.0.lua
libflame/git20190802                        |      /opt/apps/intel18/modulefiles/libflame/git20190802.lua
swig/3.0.12                                 |      /opt/apps/intel18/modulefiles/swig/3.0.12.lua
ncview/2.1.7                                |      /opt/apps/intel18/modulefiles/ncview/2.1.7.lua
loki/0.1.7                                  |      /opt/apps/intel18/modulefiles/loki/0.1.7.lua
python2/2.7.15                              |      /opt/apps/intel18/modulefiles/python2/2.7.15.lua
impi/18.0.2                                 |      /opt/apps/intel18/modulefiles/impi/18.0.2.lua
impi/18.0.0                                 |      /opt/apps/intel18/modulefiles/impi/18.0.0.lua


Total Software Modules: 30
Total LUA Modules: 30
Total non LUA Modules: 0
```

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Stampede2 Use Case (3/3)

- Previously we saw 30 modules, in /opt/app/intel18/modulefiles but there are 320 modules when counting all subtrees.
- Lua and non-lua modules are color coded which can help spot modules quickly

```
(buildtest-framework) login1(1001)$ BUILDTEST_SPIDER_VIEW=all buildtest module list
```

Full Module Name	ModuleFile Path
hpctoolkit/2017.10	/opt/apps/intel18/impi18_0/modulefiles/hpctoolkit/2017.10.lua
parallel-netcdf/4.6.2	/opt/apps/intel18/impi18_0/modulefiles/parallel-netcdf/4.6.2.lua
parallel-netcdf/4.3.3.1	/opt/apps/intel18/impi18_0/modulefiles/parallel-netcdf/4.3.3.1.lua
rosetta/3.9	/opt/apps/intel18/impi18_0/modulefiles/rosetta/3.9.lua
amask/1.0	/opt/apps/intel18/impi18_0/modulefiles/amask/1.0.lua
superlu/5.1-cxxcomplexdebug	/opt/apps/intel18/impi18_0/modulefiles/superlu/5.1-cxxcomplexdebug.lua
superlu/5.1-cxxcomplex	/opt/apps/intel18/impi18_0/modulefiles/superlu/5.1-cxxcomplex.lua
superlu/5.1-cxx	/opt/apps/intel18/impi18_0/modulefiles/superlu/5.1-cxx.lua
superlu/5.1-cxxdebug	/opt/apps/intel18/impi18_0/modulefiles/superlu/5.1-cxxdebug.lua
superlu/5.1-complexdebug	/opt/apps/intel18/impi18_0/modulefiles/superlu/5.1-complexdebug.lua
superlu/5.1	/opt/apps/intel18/impi18_0/modulefiles/superlu/5.1.lua
superlu/5.1-complex	/opt/apps/intel18/impi18_0/modulefiles/superlu/5.1-complex.lua
superlu/5.1-debug	/opt/apps/intel18/impi18_0/modulefiles/superlu/5.1-debug.lua
pnetcdf/1.11.0	/opt/apps/intel18/impi18_0/modulefiles/pnetcdf/1.11.0.lua
pnetcdf/1.8.1	/opt/apps/intel18/impi18_0/modulefiles/pnetcdf/1.8.1.lua
suitesparse/4.4.3-cxxcomplex	/opt/apps/intel18/impi18_0/modulefiles/suitesparse/4.4.3-cxxcomplex.lua
suitesparse/4.4.3-complex	/opt/apps/intel18/impi18_0/modulefiles/suitesparse/4.4.3-complex.lua
suitesparse/4.4.3-cxxdebug	/opt/apps/intel18/impi18_0/modulefiles/suitesparse/4.4.3-cxxdebug.lua
suitesparse/4.4.3-complexdebug	/opt/apps/intel18/impi18_0/modulefiles/suitesparse/4.4.3-complexdebug.lua
suitesparse/4.4.3-debug	/opt/apps/intel18/impi18_0/modulefiles/suitesparse/4.4.3-debug.lua
suitesparse/4.4.3-cxxcomplexdebug	/opt/apps/intel18/impi18_0/modulefiles/suitesparse/4.4.3-cxxcomplexdebug.lua
suitesparse/4.4.3-cxx	/opt/apps/intel18/impi18_0/modulefiles/suitesparse/4.4.3-cxx.lua
suitesparse/4.4.3	/opt/apps/intel18/impi18_0/modulefiles/suitesparse/4.4.3.lua
nwchem/6.6	/opt/apps/intel18/impi18_0/modulefiles/nwchem/6.6.lua
nwchem/6.8	/opt/apps/intel18/impi18_0/modulefiles/nwchem/6.8.lua
phdf5/1.10.4	/opt/apps/intel18/impi18_0/modulefiles/phdf5/1.10.4.lua
phdf5/1.8.16	/opt/apps/intel18/impi18_0/modulefiles/phdf5/1.8.16.lua

```
hypre/2.14-complex          |   /opt/apps/intel18/impi18_0/modulefiles/hypre/2.14-complex.lua
meep/1.6                    |   /opt/apps/intel18/impi18_0/modulefiles/meep/1.6
ls-dyna/11.0.0              |   /opt/apps/intel18/impi18_0/modulefiles/ls-dyna/11.0.0.lua
```

```
elemental/0.87-cxxdebug     |   /opt/apps/intel18/impi18_0/modulefiles/elemental/0.87-cxxdebug.lua
gamess/2017.04.20           |   /opt/apps/intel18/impi18_0/modulefiles/gamess/2017.04.20.lua
gamess/2018.02.14           |   /opt/apps/intel18/impi18_0/modulefiles/gamess/2018.02.14.lua
boost-mpi/1.68              |   /opt/apps/intel18/impi18_0/modulefiles/boost-mpi/1.68.lua
gpaw/1.5.1                  |   /opt/apps/intel18/impi18_0/modulefiles/gpaw/1.5.1.lua
hoomd/2.4.2                 |   /opt/apps/intel18/impi18_0/modulefiles/hoomd/2.4.2.lua


Total Software Modules: 320
Total LUA Modules: 319
Total non LUA Modules: 1
```

GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io

Module Load Testing (1/3)

- Buildtest can automate **module load** test for a module tree specified in BUILDTEST_MODULEPATH.
- Since v0.7.5, buildtest provides a few configuration options to control behavior of module loadtest. The following configuration can be found in **settings.yml**

```
module:
  loadtest:
    login: false
    numtest: -1
    purge_modules: true
```

- By default, buildtest will run test in sub-shell but you can run them in **login shell** if login: true
- Buildtest will purge modules before loading modules, this is controlled by purge_modules: true
- User can control how many tests to run before terminating by using numtest. A negative or zero will run all tests

GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io

Module Load Testing (2/3)

Command Executed

```
$ buildtest module loadtest --numtest 5
RUN: 1  STATUS: PASSED - Testing module command: module purge; module load xdusage/2.0; ( File: /opt/apps/xsede/modulefiles/xdusage/2.0 )

RUN: 2  STATUS: PASSED - Testing module command: module purge; module load xdusage/2.1; ( File: /opt/apps/xsede/modulefiles/xdusage/2.1 )

RUN: 3  STATUS: PASSED - Testing module command: module purge; module load gateway-usage-reporting/2.0; ( File: /opt/apps/xsede/modulefiles/gateway-
usage-reporting/2.0 )

RUN: 4 STATUS: FAILED - Testing module command: module purge; module load cue-math; ( File: /opt/apps/xsede/modulefiles/cue-math )

RUN: 5  STATUS: PASSED - Testing module command: module purge; module load teragrid-basic; ( File: /opt/apps/xsede/modulefiles/teragrid-basic )

Writing Results to /tmp/sms1990/buildtest/tests/modules-load.out
Writing Results to /tmp/sms1990/buildtest/tests/modules-load.err

                    Module Load Summary
Module Trees:                       ['/opt/apps/xsede/modulefiles']
PASSED:                             4
FAILED:                             1
```

GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io

Module Load Testing (3/3)

Command Executed

Module File Tested

```
$ buildtest module loadtest --login --numtest 5
RUN: 1  STATUS: PASSED - Testing module command: bash --login -c module purge; module load gompi/2018a; ( File: /mxg-hpc/users/ssi29/easybuild/modules/all/gompi/2018a.lua )
_____________________________________________________________________________
RUN: 2  STATUS: PASSED - Testing module command: bash --login -c module purge; module load numactl/2.0.11-GCCcore-6.4.0; ( File: /mxg-hpc/users/ssi29/easybuild/modules/all/numactl/2.0.11-GCCcore-6.4
_____________________________________________________________________________
RUN: 3  STATUS: PASSED - Testing module command: bash --login -c module purge; module load GCCcore/6.4.0; ( File: /mxg-hpc/users/ssi29/easybuild/modules/all/GCCcore/6.4.0.lua )
_____________________________________________________________________________
RUN: 4  STATUS: PASSED - Testing module command: bash --login -c module purge; module load GCCcore/7.4.0; ( File: /mxg-hpc/users/ssi29/easybuild/modules/all/GCCcore/7.4.0.lua )
_____________________________________________________________________________
RUN: 5  STATUS: PASSED - Testing module command: bash --login -c module purge; module load GCCcore/9.2.0; ( File: /mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/GCCcore/9.2.0.lua )
_____________________________________________________________________________
Writing Results to /tmp/ssi29/buildtest/tests/modules-load.out
Writing Results to /tmp/ssi29/buildtest/tests/modules-load.err

_____________________________________________________________________________
                    Module Load Summary
Module Trees:                          ['/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core', '/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core', '/mxg-hpc/users/ssi29/easybuild/module
'/usr/share/lmod/lmod/modulefiles/Core']
PASSED:                                5
FAILED:                                0

_____________________________________________________________________________
```

GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io

Reporting EasyBuild and Spack Modules


```
$ buildtest module --easybuild
Modules built with Easybuild
--------------------------------------------------------------------------------
/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/Bison/3.0.4.lua
/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/Bison/3.3.2.lua
/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/GCC/8.1.0-2.30.lua
/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/GCC/9.2.0-2.32.lua
/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/GCCcore/8.1.0.lua
/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/GCCcore/9.2.0.lua
/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/M4/1.4.17.lua
/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/M4/1.4.18.lua
/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/binutils/2.30.lua
/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/binutils/2.32.lua
/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/flex/2.6.4.lua
/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/help2man/1.47.4.lua
/mxg-hpc/users/ssi29/easybuild-HMNS/modules/all/Core/zlib/1.2.11.lua


Total Easybuild Modules: 13
Total Modules Searched: 13
```


```
$ buildtest module --spack
Modules built with Spack
--------------------------------------------------------------------------------
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/bzip2/1.0.8-etzfbao.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/diffutils/3.7-jthvt3v.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/gdbm/1.18.1-r4vohzu.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/gettext/0.20.1-c4ovdd2.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/libiconv/1.16-xcmzb6a.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/libpciaccess/0.13.5-cavw42z.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/libsigsegv/2.12-oywfhvk.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/libtool/2.4.6-swiq7rt.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/libxml2/2.9.9-azmlgc5.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/m4/1.4.18-dipchcn.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/ncurses/6.1-3jjw2re.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/pkgconf/1.6.3-oqak6dh.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/readline/8.0-bp7xnfp.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/tar/1.32-gem5z6s.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/util-macros/1.19.1-s4xjvop.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/xz/5.2.4-lvajsnj.lua
/mxg-hpc/users/ssi29/spack/modules/linux-rhel7-x86_64/Core/zlib/1.2.11-zolwez4.lua


Total Spack Modules: 17
Total Modules Searched: 17
```

GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io

Retrieving Parent Modules

- Users and administrators can quickly find all parent modules (modules that set MODULEPATH) with buildtest module --list-all-parents.
- At Stampede2 with up to 900+ modules users can find all parent modules and see all child modules from a given parent using buildtest module -d <parent-module>

```
(buildtest-framework) login1(986)$ buildtest module --list-all-parents
gcc/5.4.0 /opt/apps/modulefiles/gcc/5.4.0.lua
gcc/6.3.0 /opt/apps/modulefiles/gcc/6.3.0.lua
gcc/7.1.0 /opt/apps/modulefiles/gcc/7.1.0.lua
impi/17.0.3 /opt/apps/intel17/modulefiles/impi/17.0.3.lua
impi/17.0.3 /opt/apps/intel16/modulefiles/impi/17.0.3.lua
impi/17.0.3 /opt/apps/gcc7_1/modulefiles/impi/17.0.3.lua
impi/17.0.3 /opt/apps/gcc5_4/modulefiles/impi/17.0.3.lua
impi/18.0.0 /opt/apps/gcc7_1/modulefiles/impi/18.0.0.lua
impi/18.0.0 /opt/apps/intel17/modulefiles/impi/18.0.0.lua
impi/18.0.0 /opt/apps/intel18/modulefiles/impi/18.0.0.lua
impi/18.0.0 /opt/apps/gcc6_3/modulefiles/impi/18.0.0.lua
impi/18.0.2 /opt/apps/intel18/modulefiles/impi/18.0.2.lua
impi/18.0.2 /opt/apps/intel17/modulefiles/impi/18.0.2.lua
impi/18.0.2 /opt/apps/gcc6_3/modulefiles/impi/18.0.2.lua
impi/18.0.2 /opt/apps/gcc7_1/modulefiles/impi/18.0.2.lua
intel/16.0.3 /opt/apps/modulefiles/intel/16.0.3.lua
intel/17.0.4 /opt/apps/modulefiles/intel/17.0.4.lua
intel/18.0.0 /opt/apps/modulefiles/intel/18.0.0.lua
intel/18.0.2 /opt/apps/modulefiles/intel/18.0.2.lua
```

```
(buildtest-framework) login1(990)$ buildtest module -d gcc/5.4.0
Module File: /opt/apps/modulefiles/gcc/5.4.0.lua
Modules that depend on gcc/5.4.0
/opt/apps/gcc5_4/modulefiles/impi/17.0.3.lua
/opt/apps/gcc5_4/modulefiles/mkl/17.0.4.lua


Total Modules Found: 2
```

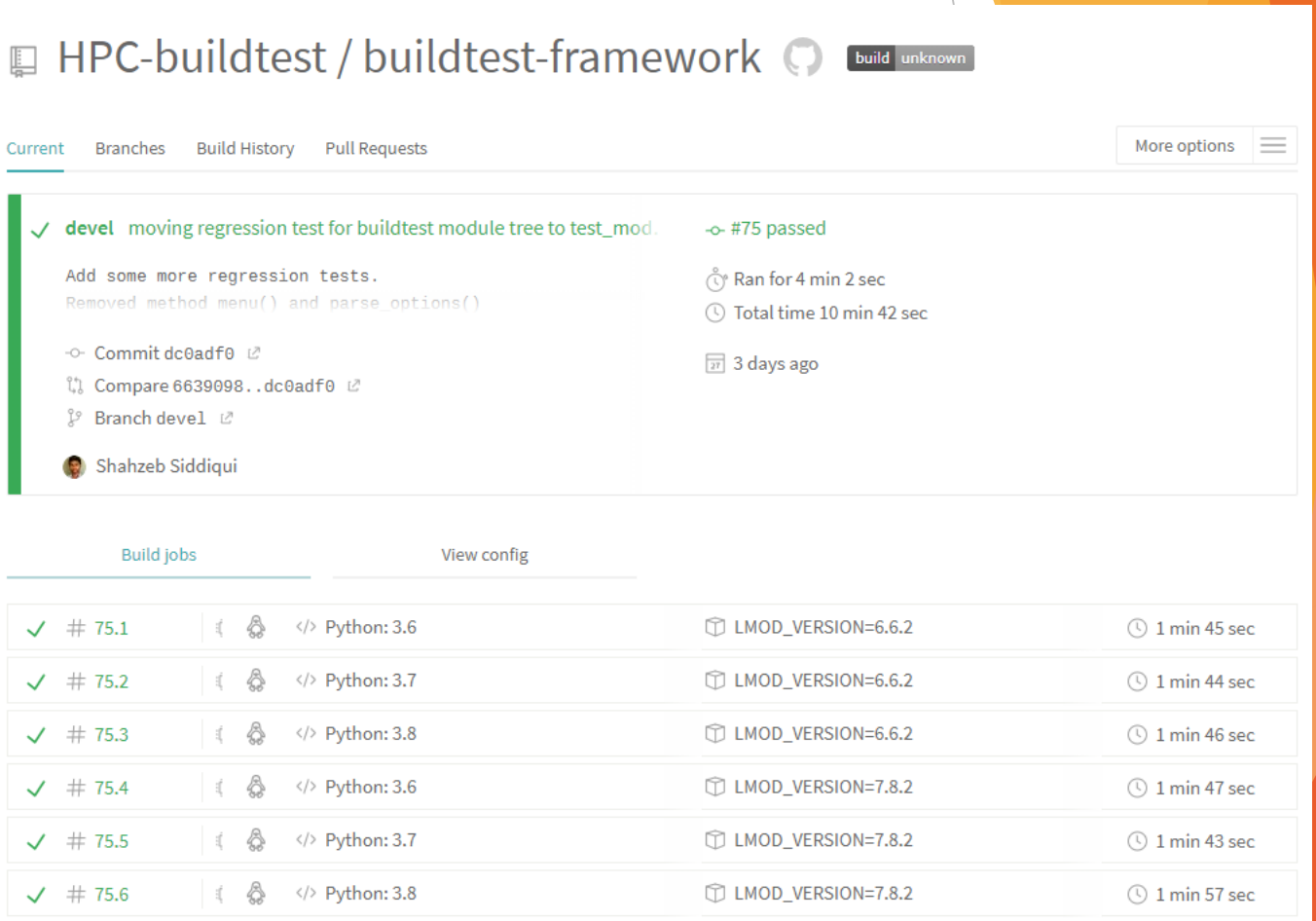
```
(buildtest-framework) login1(995)$ buildtest module -d gcc/6.3.0
Module File: /opt/apps/modulefiles/gcc/6.3.0.lua
Modules that depend on gcc/6.3.0
/opt/apps/gcc6_3/modulefiles/impi/18.0.2.lua
/opt/apps/gcc6_3/modulefiles/impi/18.0.0.lua
/opt/apps/gcc6_3/modulefiles/mkl/18.0.0.lua
/opt/apps/gcc6_3/modulefiles/mkl/18.0.2.lua


Total Modules Found: 4
```

GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io

Travis

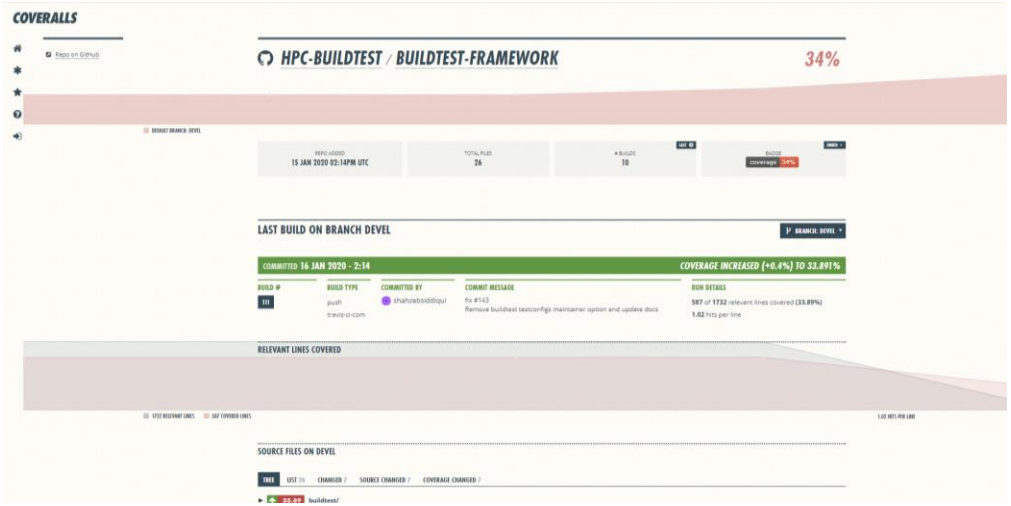
- Since v0.7.4, buildtest can run its regression test in Travis. Several improvement to Travis configuration in v0.7.5
- Currently, buildtest contains approximately 30+ regression tests
- Some regression tests rely on having a software stack, so buildtest builds a mini stack using easybuild.
- Buildtest is tested for Python 3.6, 3.7, 3.8 and Lmod version 6.6.2 and 7.8.2

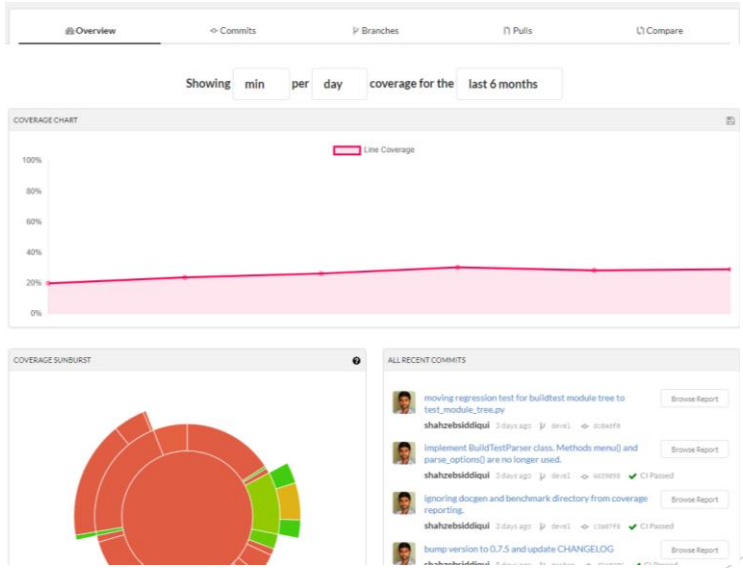


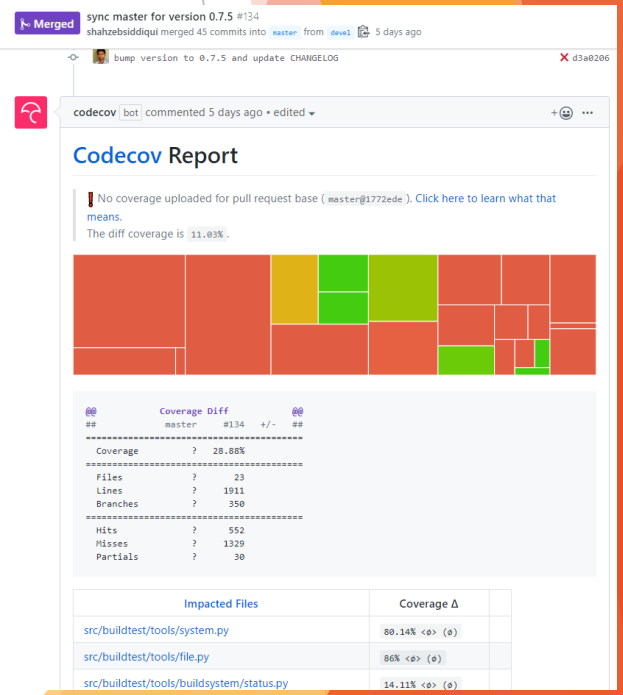
GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io

Coverage Report

- Since v0.7.5, buildtest can capture coverage report via codecov that is found at https://codecov.io/gh/HPC-buildtest/buildtest-framework
- Coverage report is automatically reported by **codecov** bot on pull requests
- Coverals provides in-depth and more user-friendly coverage report like codecov







GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io

Current Challenges

- Travis Build Timeouts if job takes more than 50mins. Buildtest requires a software stack to run some of its regression tests
- Currently, buildtest installs easybuild and lets eb installs 2-3 software to get software stack to test some module functionality
- One approach is to build easybuild containers via singularity and pull images in Travis build and rewrite some regression test to test against containers

GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io

Easybuild Singularity Container Workflow

```
#1. Generate Singularity Definition File from Easybuild
eb binutils-2.28.eb -C --experimental --container-config bootstrap=yum,osversion=7

#2. Create Access Token from Sylabs and login
singularity remote login

#3. build container on Sylabs builder
singularity build --remote binutils-2.28.sif Singularity.binutils-2.28

#4a. Generate Key if you dont have one. If you have key then sign the container
singularity key newpair

#4b. List your Key pair
singularity key list

#4c. In Step 4a. if you select N in Would you like to push it to the keystore? [Y,n]
singularity key push <KEY>

#5. Sign & Verify your container
singularity sign binutils-2.28.sif
singularity verify binutils-2.28.sif

#6. Push container to your library
singularity push binutils-2.28.sif library://shahzebmsiddiqui/easybuild/binutils:2.28
```

GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io

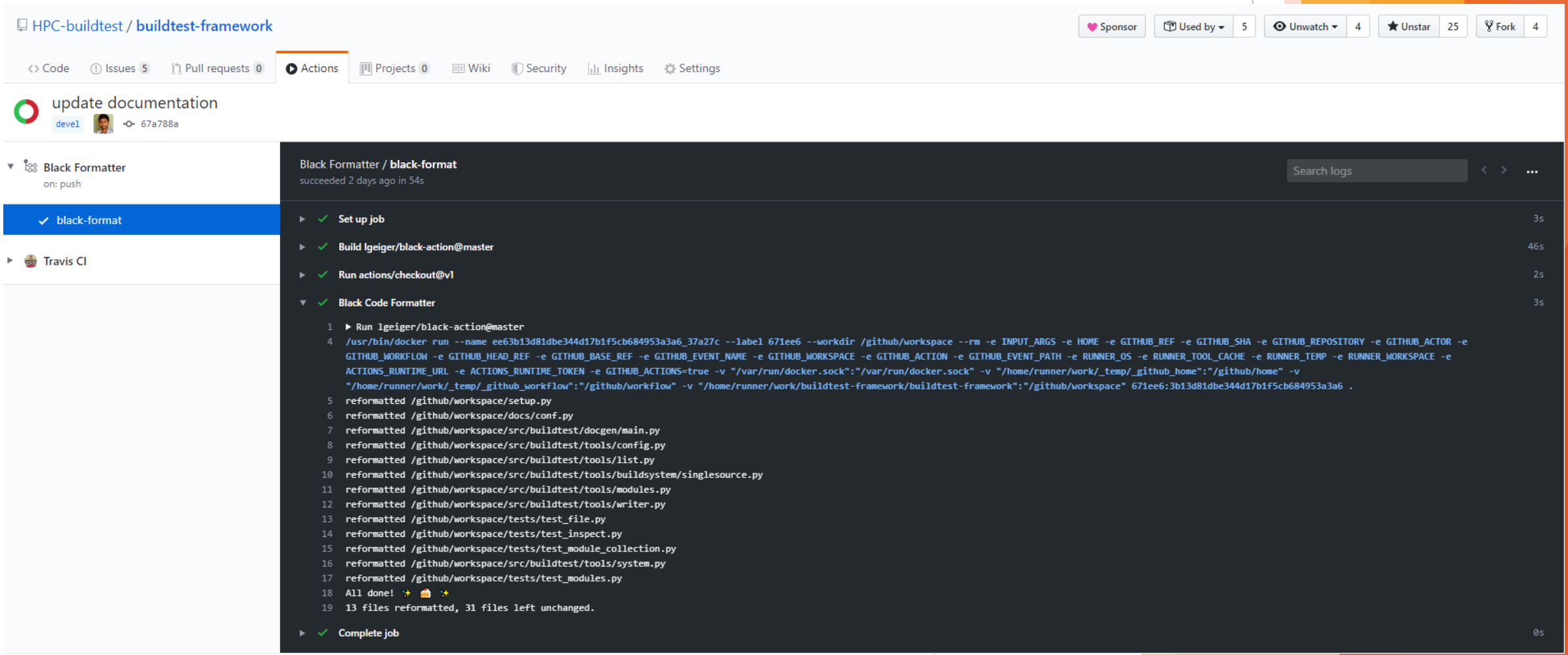
GitHub Integration

- GitHub Apps Integration
  - CI: Travis
  - Code Quality: CodeCov, Coveralls, CodeFactor
  - Security: Snyk, GuardRails
- GitHub Bot Integration
  - Issue-Label Bot (https://github.com/marketplace/issue-label-bot)
  - Stale (https://github.com/marketplace/stale)
  - Trafico (https://github.com/marketplace/trafico-pull-request-labeler)
  - Pull-Request-Size (https://github.com/marketplace/pull-request-size)
- GitHub Action Integration
  - Black Code Formatter (https://github.com/marketplace/actions/black-code-formatter)
  - URLs-checker (https://github.com/marketplace/actions/urls-checker)

GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io

Autoformat Python Code with Black

- Buildtest codebase is automatically formatted upon push and pull request using GitHub Workflow Action Black Code Formatter (https://github.com/marketplace/actions/black-code-formatter)



Future Work

- Current YAML schema has some limitation that do not address the following
  - Declaring variables in tests
  - Test permutation (compilation flags, multiple runs, environment variables, compilers)
  - Running test with a range of values (i.e running OpenMP program with range of threads OMP_NUM_THREADS=[1-40])
  - Support for multiple source compilation
- Merge building and execution of test into one operation. Currently the two operations are separated
- Increase coverage report for regression tests

GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io

Reference

Slack Channel	https://hpcbuildtest.slack.com/
Join Slack via Heroku	https://hpcbuildtest.herokuapp.com/
Documentation	http://buildtest.readthedocs.io/
GitHub	https://github.com/HPC-buildtest/buildtest-framework
ReadTheDocs	https://readthedocs.org/projects/buildtest/
Codecov	https://codecov.io/gh/HPC-buildtest/buildtest-framework
Travis	https://travis-ci.com/HPC-buildtest/buildtest-framework
Coverall	https://coveralls.io/github/HPC-buildtest/buildtest-framework
CodeFactor	https://www.codefactor.io/repository/github/hpc-buildtest/buildtest-framework
Snyk	https://app.snyk.io/org/hpc-buildtest/
GuardRails	https://dashboard.guardrails.io/default/gh/HPC-buildtest

GitHub: https://github.com/HPC-buildtest/buildtest-framework
Documentation: http://buildtest.rtfd.io