



**XRootD**

# Evolution of Testing and CI Infrastructure

G. Amadio

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# XRootD/EOS are of critical importance to CERN/HEP

- ▶ Need to provide rock solid stability
- ▶ One of the pillars upon which EOS is built
  - EOS will reach over 750 PB of data across instances at CERN in 2023
- ▶ XRootD protocol used by many physicists (with ROOT) for their analysis
- ▶ Scale: many thousands of clients active at any given moment
- ▶ Data volume will increase by 10x with HL-LHC, we need to be ready for it
- ▶ Goal: evolve testing infrastructure to find as many problems/bugs as possible before they reach any production environment

# GitHub Actions vs GitLab CI

✓ [XrdSys] Avoid memory leak report in asan when overwriting the default... #936

Summary

Jobs

- ✓ cmake-almalinux8
- ✓ cmake-almalinux9
- ✓ cmake-alpine-musl
- ✓ cmake-centos7
- ✓ cmake-centos7-updated-python
- ✓ cmake-centos7-python2
- ✓ cmake-ubuntu-updated-python
- ✓ cmake-macos
- ✓ rpm-centos7
- ✓ rpm-fedora
- ✓ dpkg-ubuntu
- ✓ sdist-centos7
- ✓ sdist-centos7-updated-python
- ✓ sdist-ubuntu

Run details

- Usage
- Workflow file

Triggered via push yesterday

abh3 pushed → c91b1ac master

Status: **Success** Total duration: **17m 33s**

**build.yml**  
on: push

✓ cmake-almalinux8	14m 15s
✓ cmake-almalinux9	17m 2s
✓ cmake-alpine-musl	14m 53s
✓ cmake-centos7	10m 56s
✓ cmake-centos7-updated...	11m 2s
✓ cmake-centos7-python2	11m 19s
✓ cmake-ubuntu-updated...	12m 45s
✓ cmake-macos	11m 48s
✓ rpm-centos7	17m 17s
✓ rpm-fedora	15m 27s
✓ dpkg-ubuntu	11m 12s
✓ sdist-centos7	5m 36s
✓ sdist-centos7-updated-py...	7m 6s
✓ sdist-ubuntu	3m 30s

**build:rpm**

- ✓ build.cc7
- ✓ build.cs8
- ✓ build.cs9
- ✓ build.deb\_ubuntu\_focal
- ✓ build.deb\_ubuntu\_jammy
- ✓ build.fedora-34
- ✓ build.fedora-35
- ✓ build.fedora-36
- ! build.macosx

**publish**

- ✓ publish.debian
- ✓ publish.rhel

**build:rpm**

- ✓ release.cc7-x86\_64
- ✓ release.cs8-x86\_64
- ✓ release.deb\_ubuntu\_bionic
- ✓ release.deb\_ubuntu\_focal
- ✓ release.deb\_ubuntu\_jammy
- ✓ release.pypi
- ✓ release.rocky8-x86\_64

**publish**

- ✓ publish.debian:release
- ✓ publish.pypi
- ✓ publish.rhel:release

**post:publish**

- ⊛ publish.koji:cc7
- ⊛ publish.koji:cs8

# Recent Developments

- ▶ Linux distribution recommendation changed from CentOS Stream to Alma
  - Added builds on Alma Linux 8 and Alma Linux 9 to XRootD GitHub Actions
  - Adapted docker based tests to work on Alma 8 and Alma 9 in addition to CentOS 7
- ▶ Added a build on Alpine Linux (musl-based Linux distribution)
- ▶ Dropped build on Ubuntu 18 (not supported anymore)
  - CMake is too old (3.15), we now require CMake 3.16 or newer (due to FindPython.cmake)
- ▶ Moved Fedora 35 build to Fedora 37
- ▶ Removed branch filters, now CI runs on all branches and pull requests
- ▶ Planned: builds with clang on Linux, static analysis with clang-tidy, coverage

# Static Analysis Example (clang-tidy)

```
xrootd/src/XrdCl/XrdClFile.cc:236:19: warning: Access to field 'length' results in a dereference
of a null pointer (loaded from variable 'chunkInfo') [clang-analyzer-core.NullDereference]
    bytesRead = chunkInfo->length;
                ^~~~~~
xrootd/src/XrdCl/XrdClFile.cc:229:5: note: Taking false branch
    if( !st.IsOK() )
    ^
xrootd/src/XrdCl/XrdClFile.cc:232:5: note: 'chunkInfo' initialized to a null pointer value
    ChunkInfo *chunkInfo = 0;
    ^~~~~~
xrootd/src/XrdCl/XrdClFile.cc:233:27: note: Calling 'MessageUtils::WaitForResponse'
    XRootDStatus status = MessageUtils::WaitForResponse( &handler, chunkInfo );
                          ^~~~~~
xrootd/src/./XrdCl/XrdClMessageUtils.hh:179:9: note: Taking false branch
    if( ret.IsOK() )
    ^
xrootd/src/./XrdCl/XrdClMessageUtils.hh:191:9: note: Returning without writing to 'response'
    return ret;
    ^
xrootd/src/XrdCl/XrdClFile.cc:233:27: note: Returning from 'MessageUtils::WaitForResponse'
    XRootDStatus status = MessageUtils::WaitForResponse( &handler, chunkInfo );
                          ^~~~~~
xrootd/src/XrdCl/XrdClFile.cc:234:5: note: Taking true branch
    if( status.IsOK() )
    ^
src/XrdCl/XrdClFile.cc:236:19:
note: Access to field 'length' results in a dereference of a null pointer (loaded from variable 'chunkInfo')
    bytesRead = chunkInfo->length;
                ^~~~~~
```

# GitHub Problem Matchers

## Summary

### Jobs

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- ✓ sdist-ubuntu

### Run details

- 🕒 Usage
- 📄 Workflow file

## Annotations

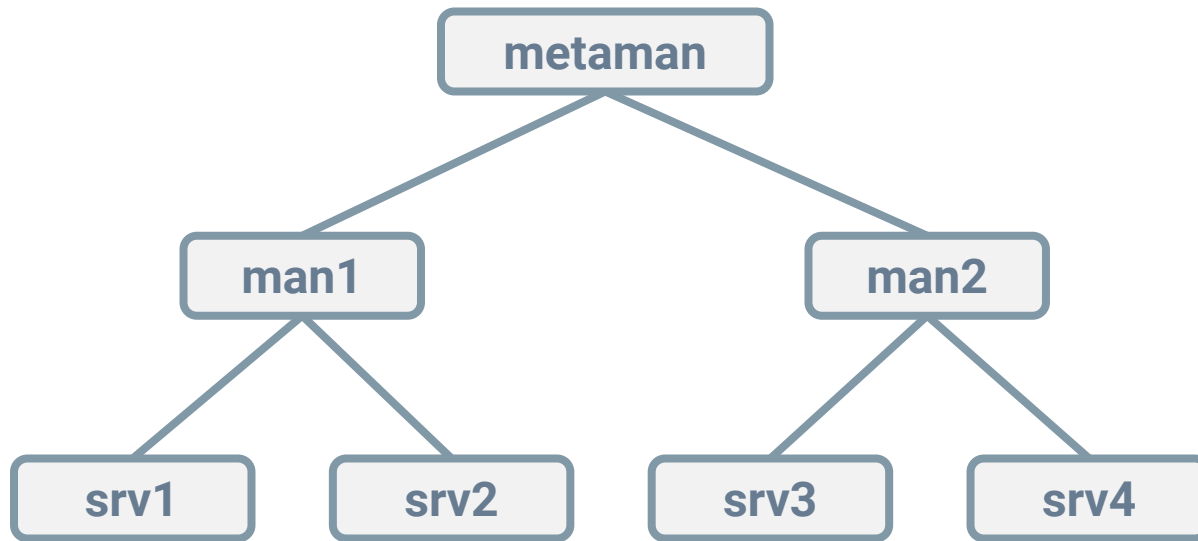
10 warnings

- ⚠️ **cmake-macos:** src/XrdPosix/XrdPosixAdmin.cc#L171  
result of comparison of constant 46116860184273879 with expression of type 'unsigned int' is always false [-Wtautological-constant-out-of-range-compare]
- ⚠️ **cmake-macos:** src/XrdPosix/XrdPosixFile.hh#L169  
'Who' overrides a member function but is not marked 'override' [-Winconsistent-missing-override]
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'Who' overrides a member function but is not marked 'override' [-Winconsistent-missing-override]
- ⚠️ **cmake-macos:** src/XrdPss/XrdPss.hh#L147  
'newDir' overrides a member function but is not marked 'override' [-Winconsistent-missing-override]
- ⚠️ **cmake-macos:** src/XrdPss/XrdPss.hh#L149  
'newFile' overrides a member function but is not marked 'override' [-Winconsistent-missing-override]

# Docker Tests

- ▶ Existing tests in repository on GitLab
  - <https://gitlab.cern.ch/eos/xrootd-docker>
- ▶ Converted this setup into **xrd-docker** script
  - Subcommands
    - fetch - download data
    - package - create XRootD tarball
    - build - build docker images
    - setup - setup containers
    - run - run tests
    - clean - clean up running containers and drop testing network
  - Pull request with latest version: <https://github.com/xrootd/xrootd/pull/1974>
- ▶ Operating Systems: CentOS 7, Alma 8, Alma 9
- ▶ Planned to be included in XRootD 5.6 release

# XRootD Docker Testing Setup





# Testing with CMake/CTest

- ▶ Tests need to be easy to run
- ▶ No special knowledge should be required
- ▶ Gives confidence to external contributors that they are not breaking anything when making changes to the code
- ▶ Everyone knows the “standard” workflows
  - Autotools
    - `configure && make && make test`
- ▶ Provide similar experience with CMake
  - `cmake && make && ctest`

```
$ cat tests/XrdCl/CMakeLists.txt

add_executable(xrdcl-unit-tests
  XrdClURL.cc
)

target_link_libraries(xrdcl-unit-tests
  XrdCl
  XrdXml
  XrdUtils
  GTest::GTest
  GTest::Main
)

target_include_directories(xrdcl-unit-tests
  PRIVATE ${CMAKE_SOURCE_DIR}/src
)

gtest_discover_tests(xrdcl-unit-tests TEST_PREFIX XrdCl::)
```

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```
$ cmake -S xrootd -B xrootd_build
-- The C compiler identification is GNU 12.2.1
-- The CXX compiler identification is GNU 12.2.1
-- Detecting C compiler ABI info
-- Detecting C compiler ABI info - done
-- Check for working C compiler: /usr/lib/ccache/bin/cc - skipped
-- Detecting C compile features
-- Detecting C compile features - done
-- Detecting CXX compiler ABI info
-- Detecting CXX compiler ABI info - done
. . .
-- Build files have been written to: xrootd_build

$ cmake --build xrootd_build --parallel $(nproc)
[I] src/XrdVersion.hh successfully generated
[ 0%] Built target XrdVersion.hh
[ 0%] Building CXX object . . .
. . .
$ ctest
Test project xrootd_build
  Start 1: XrdCl::URLTest.LocalURLs
1/6 Test #1: XrdCl::URLTest.LocalURLs ..... Passed    0.01 sec
  Start 2: XrdCl::URLTest.RemoteURLs
2/6 Test #2: XrdCl::URLTest.RemoteURLs ..... Passed    0.16 sec
  Start 3: XrdCl::URLTest.InvalidURLs
. . .
  Start 6: XrdCl::Utils
6/6 Test #6: XrdCl::Utils ..... Passed    8.01 sec

100% tests passed, 0 tests failed out of 6

Total Test time (real) = 13.23 sec
```

# Supported Platforms

- ▶ Which platforms and compilers should we support?
  - Currently, we officially support CentOS 7, Alma 8, Alma 9, Ubuntu, and macOS
  - GitHub Actions now also covers Alpine Linux (due to recently added musl libc support)
- ▶ Supporting more compilers can be beneficial
  - More opportunity to find bugs via compiler warnings
  - Be more resilient against compiler-specific features/bugs
  - More tools to apply in development (e.g. clang-tidy, clang-format)
- ▶ Clang on Linux not currently supported, maybe good to add
- ▶ What hardware architectures to support?
  - No explicit support for anything other than x86\_64 and arm64 (macOS)
  - Do our users run XRootD on unsupported architectures like PowerPC?
  - Plan to add other architectures via qemu to GitHub Actions (at least arm/arm64)



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