



Science and  
Technology  
Facilities Council

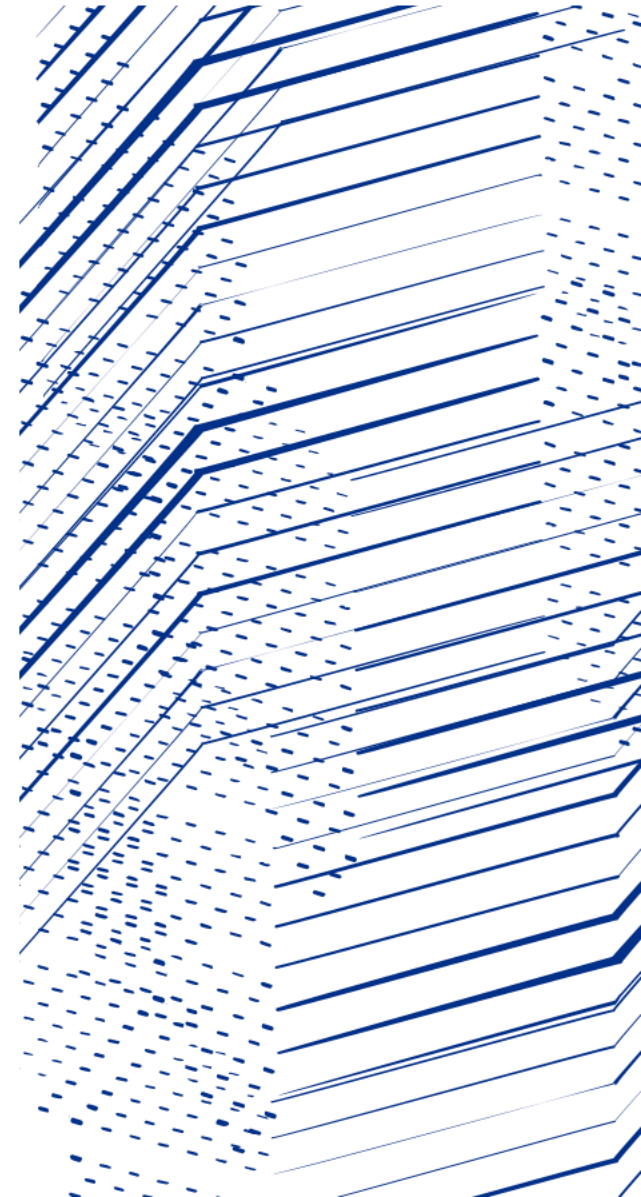
# Benchmarking XRootD: A Versatile Testing Framework for the Grid Community

Mariam Demir

[mariam.demir@stfc.ac.uk](mailto:mariam.demir@stfc.ac.uk)



Science and  
Technology  
Facilities Council



## XRootD Tests:

- CUnit
- Feature Tests
- Google Test

## Post-Deployment Tests:

- SAM
- ETF
- DDM

## XRootD Tests:

- CUnit
- Feature Tests
- Google Test

## Pre-Deployment Tests:

- Functionality
- Performance

## Post-Deployment Tests:

- SAM
- ETF
- DDM

1. How the framework is structured
2. How the setup code works
3. Some examples of test results

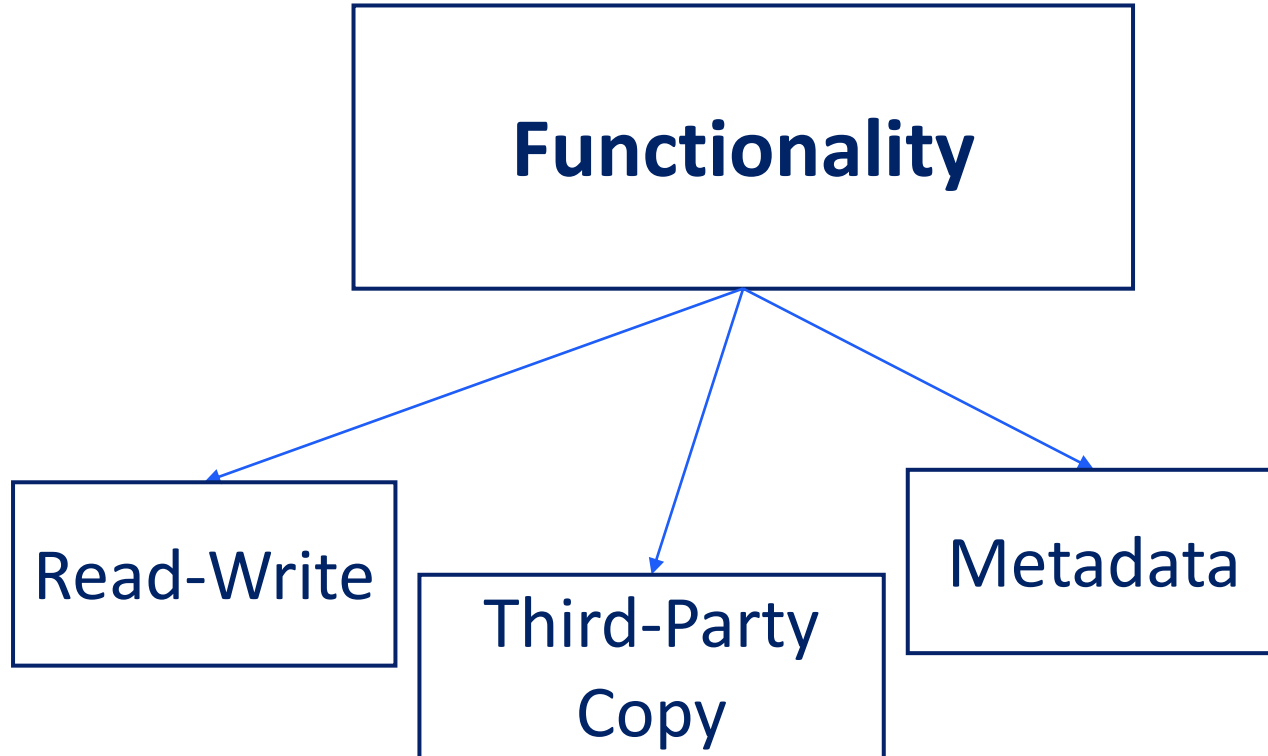
**1. How the framework is structured**

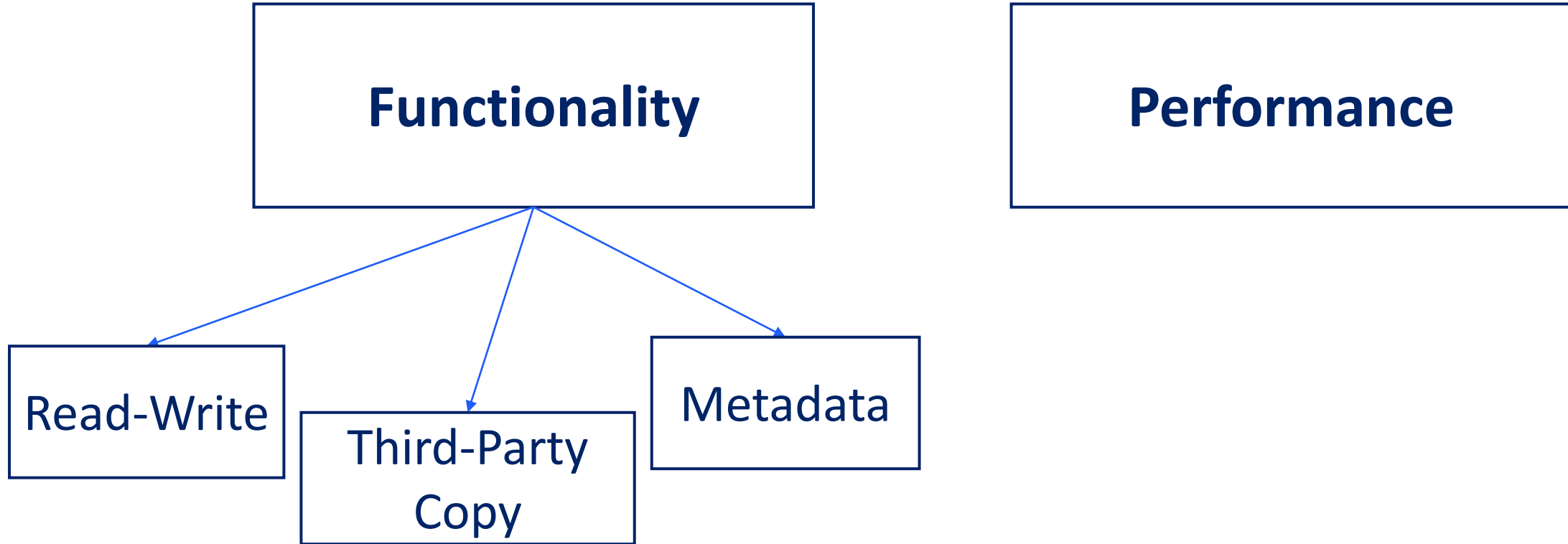
2. How the setup code works

3. Some examples of test results

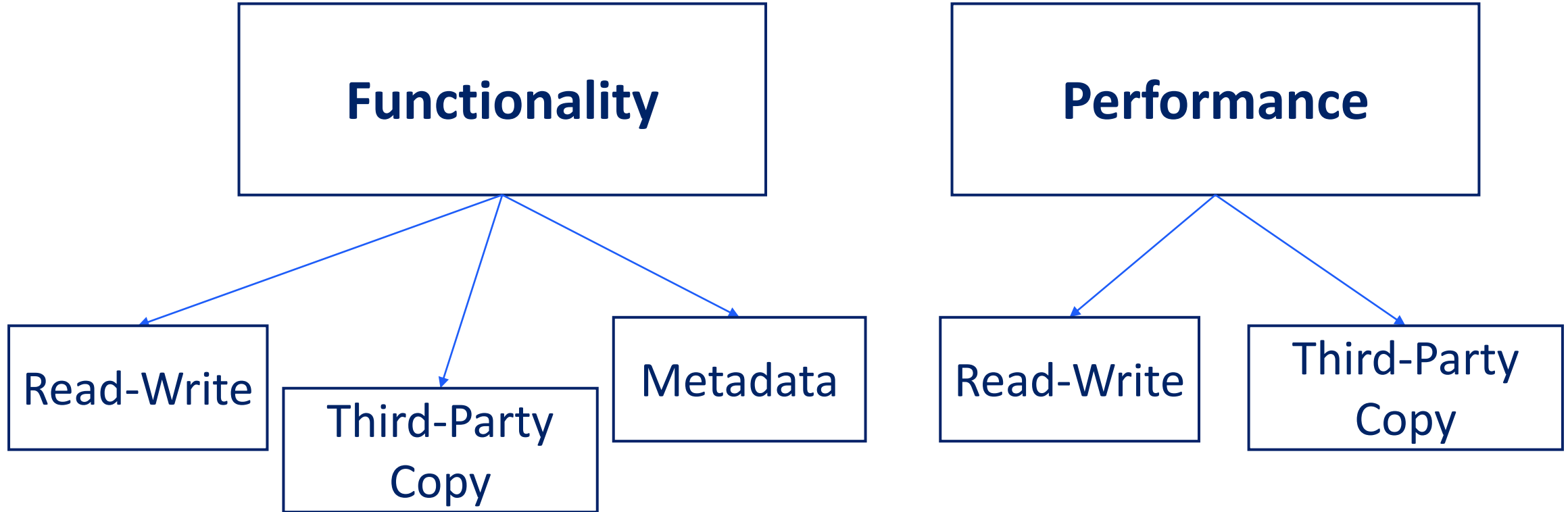


**Functionality**









## BaseTest()

- root, https, davs
- 1094
- ceph-svc16

## ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

genScenarios()  
genTimedScenarios()

## MetaDataTest()

- root, https, davs
- 1094
- ceph-svc16

genScenarios()  
genTimedScenarios()

## TPCTest()

- root, https, davs
- 1094
- ceph-svc16

genScenarios()  
genTimedScenarios()

1. How the framework is structured

**2. How the setup code works**

3. Some examples of test results

## ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

## ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16: 1095, ceph-c04, golias100, dc2-grid-64

## SITES: # Destintation SitesList

### CEPH-SVC16:

- ceph-svc16.gridpp.rl.ac.uk
- dteam:/test/
- 1095

### # CEPH-SVC02:

- # - ceph-svc02.gridpp.rl.ac.uk
- # - dteam:/test/

### CEPH-C04:

- ceph-c04.glasgow.ac.uk
- dteam:/test/

### GOLIAS100:

- se1.farm.particle.cz #golias100.farm.particle.cz
- dpm/farm.particle.cz/home/dteam/test/

### DC2-GRID-64:

- dc2-grid-64.brunel.ac.uk
- dpm/brunel.ac.uk/home/dteam/test/

ReadWriteTest(https=False)

- root, davs
- ceph-svc16: 1095,  
ceph-c04,  
goliass100,  
dc2-grid-64

SITES: # Destintation SitesList

CEPH-SVC16:

- ceph-svc16.gridpp.rl.ac.uk
- dteam:/test/
- 1095

# CEPH-SVC02:

- # - ceph-svc02.gridpp.rl.ac.uk
- # - dteam:/test/

CEPH-C04:

- ceph-c04.glasgow.ac.uk
- dteam:/test/

GOLIAS100:

- se1.farm.particle.cz #goliass100.farm.particle.cz
- dpm/farm.particle.cz/home/dteam/test/

DC2-GRID-64:

- dc2-grid-64.brunel.ac.uk
- dpm/brunel.ac.uk/home/dteam/test/

ReadWriteTest(https=False,  
createFiles=True)

- root, davs
- ceph-svc16,  
ceph-c04,  
goliath100,  
dc2-grid-64

DIRECTORY: ../TestData/bulkData

FILES:

- name: tst40M.txt  
| size: 41943040 # File size in bytes
- name: tst2.txt  
| size: 1024\*20

ReadWriteTest(https=False,  
createFiles=True)

- root, davs
- ceph-svc16,  
ceph-c04,  
goliath100,  
dc2-grid-64

```
DIRECTORY: ../TestData/bulkData  
FILES:  
- name: tst40M.txt  
  size: 41943040 # File size in bytes  
- name: tst2.txt  
  size: 1024*20
```





## ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

## ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

xrdcp tst.txt root://ceph-  
svc16.grid.rl.ac.uk:1094//dteam:/test/tst.txt\_root\_xrd

gfal-copy tst.txt https://ceph-  
svc16.grid.rl.ac.uk:1094//dteam:/test/tst.txt\_https\_gfal

gfal-copy tst.txt davs://ceph-  
svc16.grid.rl.ac.uk:1094//dteam:/test/tst.txt\_davs\_gfal

## ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

xrdcp tst.txt root://ceph-  
svc16.grid.rl.ac.uk:1094//dteam:/test/tst.txt\_root\_xrd

gfal-copy tst.txt https://ceph-  
svc16.grid.rl.ac.uk:1094//dteam:/test/tst.txt\_https\_gfal

gfal-copy tst.txt davs://ceph-  
svc16.grid.rl.ac.uk:1094//dteam:/test/tst.txt\_davs\_gfal

subprocess.run(cmd1) → [ (0, "SUCCESS", "")  
subprocess.run(cmd2) → (124, "Permission Denied", "")  
subprocess.run(cmd3) → (0, "SUCCESS", "") ]

## ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

xrdcp tst.txt root://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/tst.txt\_root\_xrd

gfal-copy tst.txt https://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/tst.txt\_https\_gfal

gfal-copy tst.txt davs://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/tst.txt\_davs\_gfal

subprocess.run(cmd1)

subprocess.run(cmd2)

subprocess.run(cmd3)

[

(0, "SUCCESS", "")

(124, "Permission Denied", "")

(0, "SUCCESS", "")

]

## Scenarios:

ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

xrdcp tst.txt root://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/tst.txt\_root\_xrd

gfal-copy tst.txt https://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/tst.txt\_https\_gfal

gfal-copy tst.txt davs://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/tst.txt\_davs\_gfal

Run Scenario 1:

subprocess.run(cmd1)



[  
(0, "SUCCESS", "")

Run Scenario 2:

subprocess.run(cmd2)



(124, "Permission Denied", "")

Run Scenario 3:

subprocess.run(cmd3)



(0, "SUCCESS", "")  
]

```
cmdOut = [(0, "SUCCESS", "")
          (124, "Permission Denied", "")
          (0, "SUCCESS", "")]
```

```
metafunc.parametrize("cmdOut", cmdOut, ids=ids)
```

```
def test_copy(self, cmdOut):
    returncode, stdout, stderr = cmdOut
    assert returncode == 0, f"Upload Failed: {stdout}, {stderr}"
```

```
cmdOut = [ (0, "SUCCESS", "")  
           (124, "Permission Denied", "")  
           (0, "SUCCESS", "") ]  
  
metafunc.parametrize("cmdOut", cmdOut, ids=ids)  
  
def test_copy(self, cmdOut):  
    returncode, stdout, stderr = cmdOut  
    assert returncode == 0, f"Upload Failed: {stdout}, {stderr}"
```

**PASS**

```
cmdOut = [ (0, "SUCCESS", "")
            (124, "Permission Denied", "")
            (0, "SUCCESS", "") ]

metafunc.parametrize("cmdOut", cmdOut, ids=ids)

def test_copy(self, cmdOut):
    returncode, stdout, stderr = cmdOut
    assert returncode == 0, f"Upload Failed: {stdout}, {stderr}"
```

**FAIL**



```
cmdOut = [(0, "SUCCESS", "")
          (124, "Permission Denied", "")
          (0, "SUCCESS", "")]

metafunc.parametrize("cmdOut", cmdOut, ids=ids)

def test_copy(self, cmdOut):
    returncode, stdout, stderr = cmdOut
    assert returncode == 0, f"Upload Failed: {stdout}, {stderr}"
```

**PASS**

```
cmdOut = [ (0, "SUCCESS", "")      root:CEPH-SVC16-tst.txt
           (124, "Permission Denied", "")  https:CEPH-SVC16-tst.txt
           (0, "SUCCESS", "") ]           davs:CEPH-SVC16-tst.txt

metafunc.parametrize("cmdOut", cmdOut, ids=ids)

def test_copy(self, cmdOut):
    returncode, stdout, stderr = cmdOut
    assert returncode == 0, f"Upload Failed: {stdout}, {stderr}"
```

**PASS**

## ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

- **genScenarios()**

ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

genScenarios()

<root://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/>  
<https://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/>  
<davs://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/>

ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

genScenarios()

XRootD

Gfal2

Gfal2

<root://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/>

<https://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/>

<davs://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/>

ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

genScenarios()

XRootD

`root://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/`

Gfal2

`https://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/`

Gfal2

`davs://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/`

```
def genScenarios(self, action:str
```

ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

genScenarios()

XRootD <root://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/>  
Gfal2 <https://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/>  
Gfal2 <davs://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/>

```
def genScenarios(self, action:str
```

**Copy:** Transfer a file to destination

**Delete:** Delete destination file

**Checksum:** Obtain destination file's checksum

**Readv:** Vector reads on source and destination file

**Load:** Batch transfer of multiple files

**Bulk-Delete:** Delete multiple destination files

ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

genScenarios()

**genTimedScenarios()**

XRootD

Gfal2

Gfal2

<root://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/>

<https://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/>

<davs://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/>



ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

genScenarios()

**genTimedScenarios()**

XRootD

root://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/

Gfal2

https://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/

Gfal2

davs://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/

➤ Get System Start Time

➤ Run Command

➤ Get System End Time

➤ Get Total Time

**Repeat  
3 Times**

ReadWriteTest()

- root, https, davs
- 1094
- ceph-svc16

genScenarios()

**genTimedScenarios()**

XRootD

root://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/

Gfal2

https://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/

Gfal2

davs://ceph-svc16.grid.rl.ac.uk:1094//dteam:/test/

➤ Get System Start Time

➤ Run Command

➤ Get System End Time

➤ Get Total Time

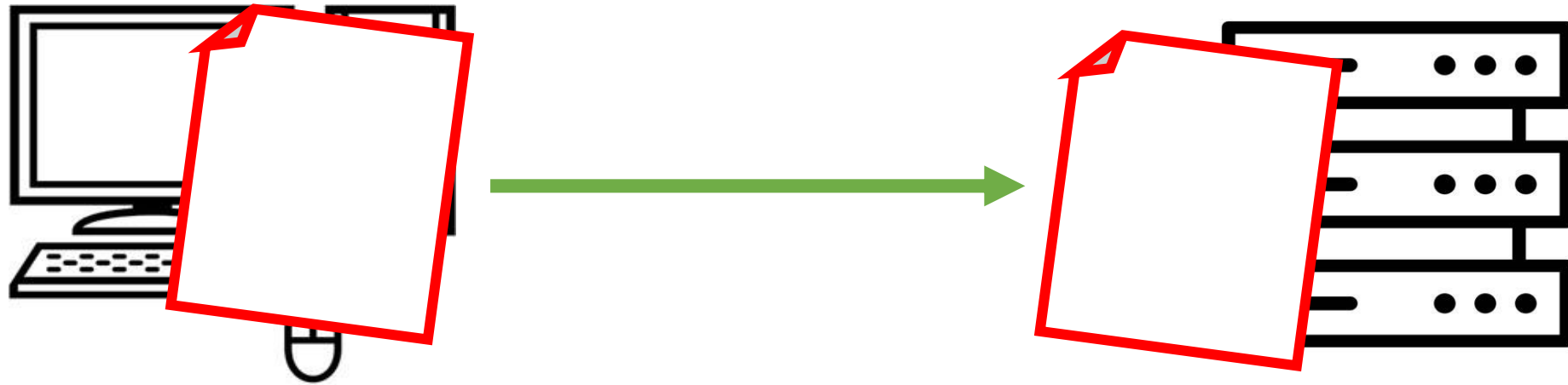
**Repeat  
3 Times**

output = (0, "SUCCESS", ""), **averageTime**

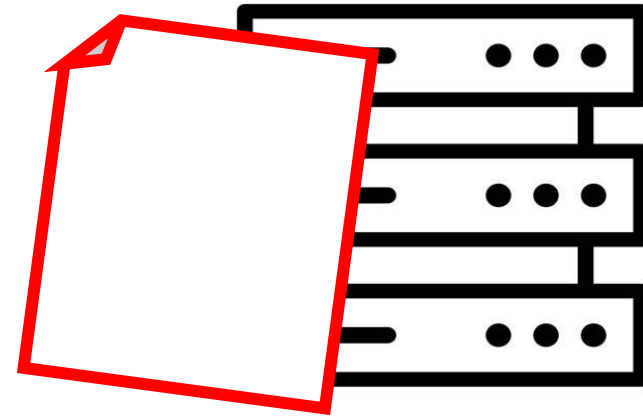
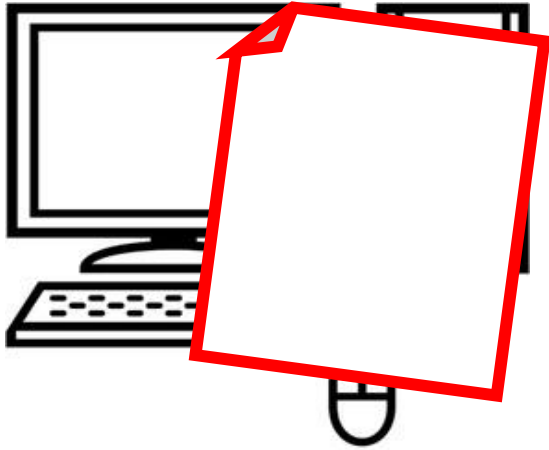
1. How the framework is structured
2. How the setup code works
- 3. Some examples of test results**

```
''' Transfer files to endpoints via root, https and davs, then compare checksum on server files to local file '''  
def test_copy(self, cmdOut, destsum, destderr):  
    (returncode, stdout, stderr), srcsum = cmdOut  
    assert returncode == 0, f"Upload Failed: {stdout}, {stderr}"  
    assert srcsum == destsum, f"Stat failed: Source: {srcsum}, Dest: {destsum} Error: {destderr}"
```

```
''' Transfer files to endpoints via root, https and davs, then compare checksum on server files to local file '''  
def test_copy(self, cmdOut, destsum, destderr):  
    (returncode, stdout, stderr), srcsum = cmdOut  
    assert returncode == 0, f"Upload Failed: {stdout}, {stderr}"  
    assert srcsum == destsum, f"Stat failed: Source: {srcsum}, Dest: {destsum} Error: {destderr}"
```

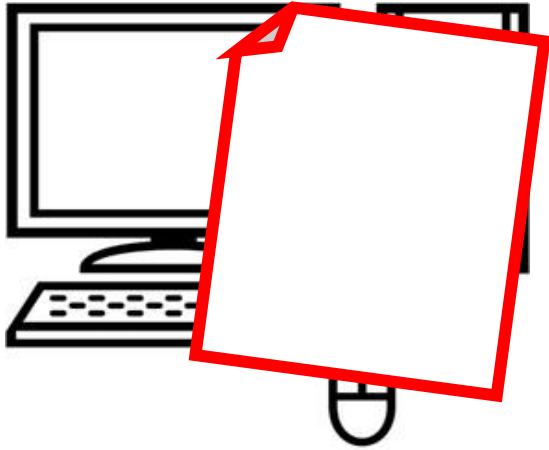


```
''' Transfer files to endpoints via root, https and davs, then compare checksum on server files to local file '''  
def test_copy(self, cmdOut, destsum, destderr):  
    (returncode, stdout, stderr), srcsum = cmdOut  
    assert returncode == 0, f"Upload Failed: {stdout}, {stderr}"  
    assert srcsum == destsum, f"Stat failed: Source: {srcsum}, Dest: {destsum} Error: {destderr}"
```

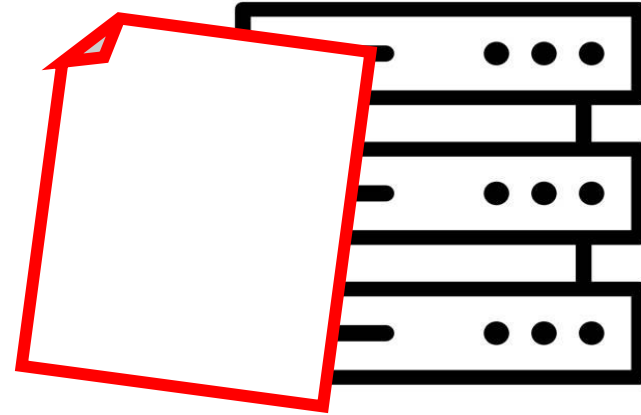


Returncode, Stdout, Stderr

```
''' Transfer files to endpoints via root, https and davs, then compare checksum on server files to local file '''  
def test_copy(self, cmdOut, destsum, destderr):  
    (returncode, stdout, stderr), srcsum = cmdOut  
    assert returncode == 0, f"Upload Failed: {stdout}, {stderr}"  
    assert srcsum == destsum, f"Stat failed: Source: {srcsum}, Dest: {destsum} Error: {destderr}"
```

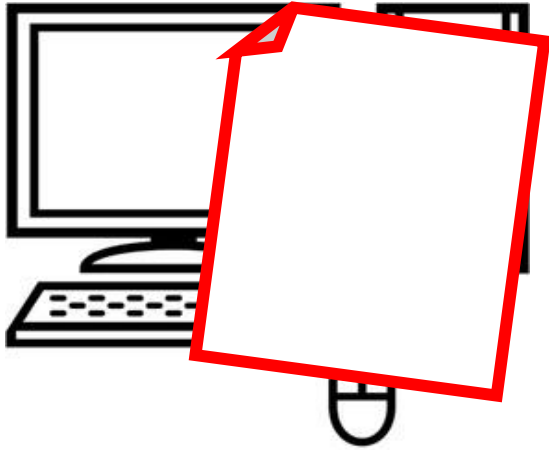


Srcsum

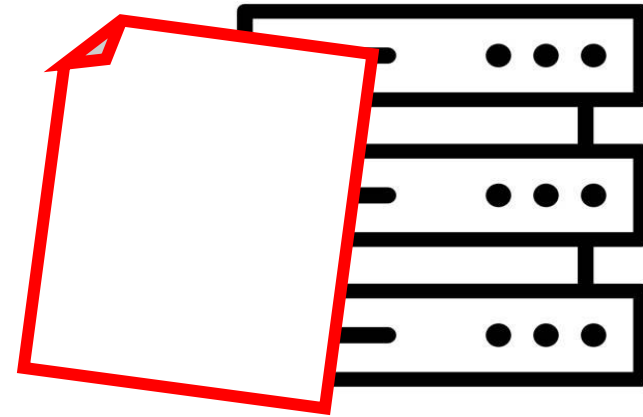


Returncode, Stdout, Stderr

```
''' Transfer files to endpoints via root, https and davs, then compare checksum on server files to local file '''  
def test_copy(self, cmdOut, destsum, destderr):  
    (returncode, stdout, stderr), srcsum = cmdOut  
    assert returncode == 0, f"Upload Failed: {stdout}, {stderr}"  
    assert srcsum == destsum, f"Stat failed: Source: {srcsum}, Dest: {destsum} Error: {destderr}"
```



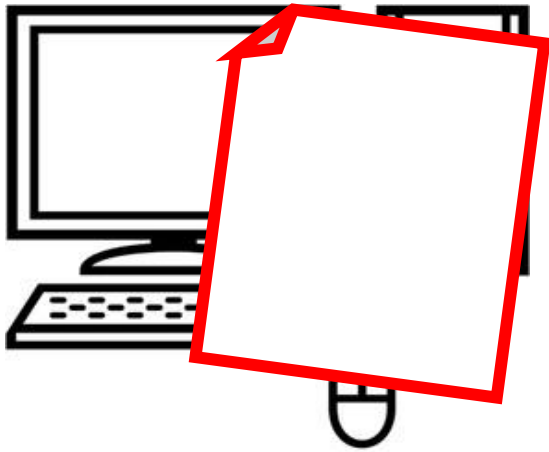
**cmdOut:** Srcsum



Returncode, Stdout, Stderr

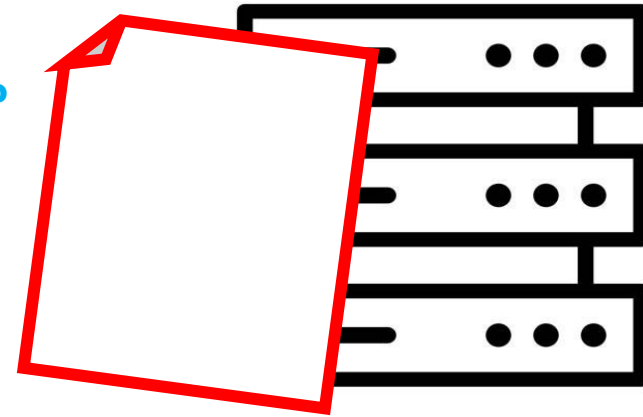


```
''' Transfer files to endpoints via root, https and davs, then compare checksum on server files to local file '''  
def test_copy(self, cmdOut, destsum, destderr):  
    (returncode, stdout, stderr), srcsum = cmdOut  
    assert returncode == 0, f"Upload Failed: {stdout}, {stderr}"  
    assert srcsum == destsum, f"Stat failed: Source: {srcsum}, Dest: {destsum} Error: {destderr}"
```



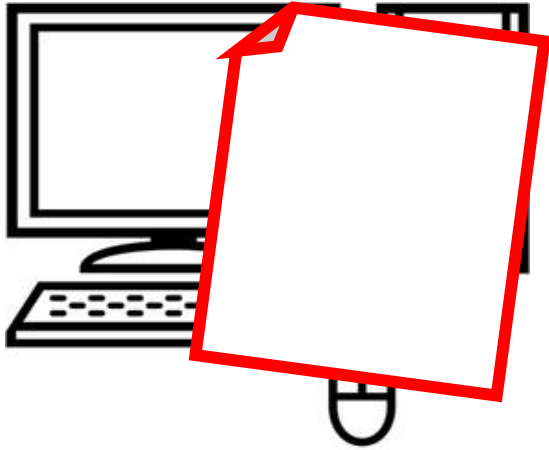
**cmdOut:** Srcsum

Checksum?



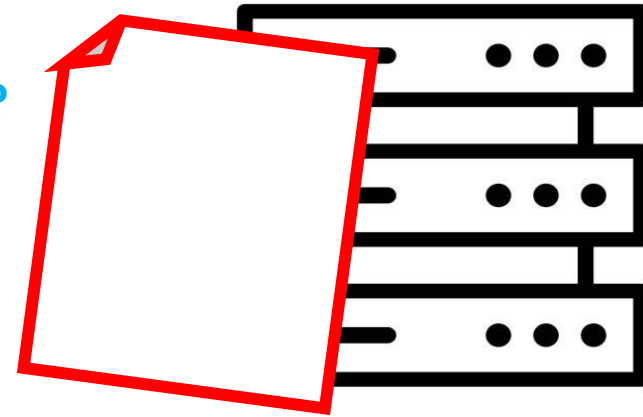
Returncode, Stdout, Stderr

```
''' Transfer files to endpoints via root, https and davs, then compare checksum on server files to local file '''  
def test_copy(self, cmdOut, destsum, destderr):  
    (returncode, stdout, stderr), srcsum = cmdOut  
    assert returncode == 0, f"Upload Failed: {stdout}, {stderr}"  
    assert srcsum == destsum, f"Stat failed: Source: {srcsum}, Dest: {destsum} Error: {destderr}"
```



**cmdOut:** Srcsum

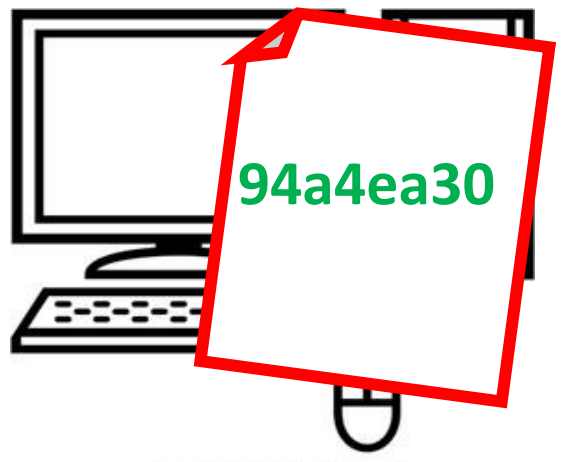
Checksum?



Returncode, Stdout, Stderr

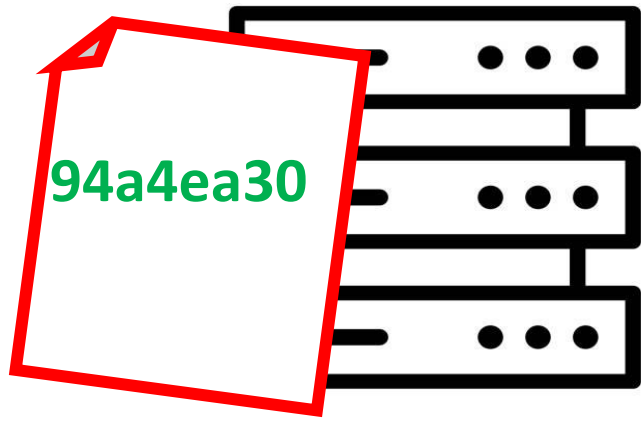
Destsum, Destderr

```
''' Transfer files to endpoints via root, https and davs, then compare checksum on server files to local file '''  
def test_copy(self, cmdOut, destsum, destderr):  
    (returncode, stdout, stderr), srcsum = cmdOut  
    assert returncode == 0, f"Upload Failed: {stdout}, {stderr}"  
    assert srcsum == destsum, f"Stat failed: Source: {srcsum}, Dest: {destsum} Error: {destderr}"
```



cmdOut: Srcsum

Checksum?



Returncode, Stdout, Stderr

Destsum, Destderr

```
(xrd_tests_env) (base) (xrd_tests_env) [efv97572@host-172-16-105-161 TestScripts]$ pytest test_example_rw.py::Test_Copy::test_copy -s -vv
===== test session starts =====
platform linux -- Python 3.9.18, pytest-8.0.0, pluggy-1.5.0 -- /home/efv97572/xrd_tests/xrd_tests_env/bin/python3
cachedir: .pytest_cache
rootdir: /home/efv97572/xrd_tests/xrd_tests/TestScripts
configfile: pytest.ini
plugins: lazy-fixtures-1.1.1, check-2.4.1, reportlog-0.4.0, allure-pytest-2.13.5
collected 3 items

test_example_rw.py::Test_Copy::test_copy[https:CEPH-SVC16-tst.txt] PASSED
test_example_rw.py::Test_Copy::test_copy[davs:CEPH-SVC16-tst.txt] PASSED
test_example_rw.py::Test_Copy::test_copy[root:CEPH-SVC16-tst.txt] PASSED

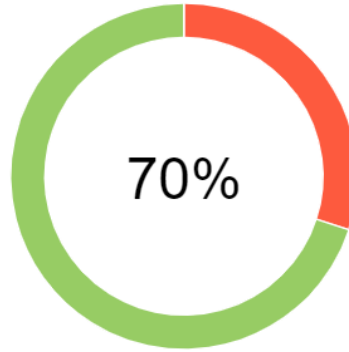
===== 3 passed in 31.06s =====
```

# 3 scenarios = 3 test cases

## ALLURE REPORT

9/11/2024

22:23:19 - 15:35:49 (85d 17h)

**30**  
test cases

## SUITES 3 items total

test_example_rw	8	20
my test suite	1	
pytest		1

[Show all](#)

## ENVIRONMENT

There are no environment variables

## TREND

There is nothing to show

## CATEGORIES 1 item total

Product defects	9
-----------------	---

[Show all](#)

## EXECUTORS

	tst40M.txt]		
✓	#42	test_40MB[https:CEPH-SVC16-tst40M.txt]	(0, 'https://ceph-svc16.gridpp.rl.ac.uk:1094//dteam:/test/tst40M.txt_https_gfal... 0s
✓	#41	test_40MB[davs:CEPH-SVC16-tst40M.txt]	(0, 'davs://ceph-svc16.gridpp.rl.ac.uk:1094//dteam:/test/tst40M.txt_davs_gfal... 0s
✗	#40	test_40MB[root:CEPH-SVC16-tst40M.txt]	(0, 'rm dteam:/test/tst40M.txt_root_xrd_CEPH-SVC16 : [SUCCESS]', ", np.flo... 0s
✗	#39	test_40MB[https:CEPH-SVC16-GOLIAS100-tst40M.txt]	[(124, "", "", np.float64(nan)), (124, "", "", np.float64(nan))], ["', 'gfal-sum err... 0s
✗	#38	test_40MB[root:CEPH-SVC16-GOLIAS100-tst40M.txt]	[(0, "", "", np.float64(3.46830423672994)), (54, "", 'Run: [ERROR] Server respon... 0s
✓	#37	test_40MB[https:CEPH-SVC16-CEPH-SVC30-tst40M.txt]	[(0, 'Copying 41943040 bytes https://ceph-svc16.gridpp.rl.ac.uk:1094//dteam... 0s
✓	#36	test_40MB[davs:CEPH-SVC16-CEPH-SVC30-	[(0, 'Copying 41943040 bytes davs://ceph-svc16.gridpp.rl.ac.uk:1094//dteam:... 0s

# Failed test\_40MB[root:CEPH-SVC16-GOLIAS100-tst40M.txt]

Overview

History

Retries

```
AssertionError: assert np.float64(3.46830423672994) <= 2.3333333333333335
```

**Deletion  
Average  
Time**

Categories: Product defects

Severity: normal

Duration: ⌚ 0s

$\text{ExpectedTimeUK} = (40 / 60) + \text{BUFFER} = 2.6667 \text{ s}$

$\text{ExpectedTimeNonUK} = (40 / 120) + \text{BUFFER} = 2.333 \text{ s}$

## Parameters

cmdOuts: [(0, "", "", np.float64(3.46830423672994)), (54, "", 'Run: [ERROR] Server responded .

**UKtarget = 60 MB/s + BUFFER**

**NonUKtarget = 120 MB/s + BUFFER**

**Passed** test\_40MB[davs:CEPH-SVC16-tst40M.txt]

UKtarget = 60 MB/s + BUFFER  
NonUKtarget = 120 MB/s + BUFFER

Overview History Retries

Severity: normal

Duration: 0s

### Parameters

cmdOuts: (0, 'davs://ceph-svc16.gridpp.rl.ac.uk:1094//dteam:/test/tst40M.txt\_davs\_gfal\_CEPH-SVC16\tDELETED', ", np.float64 0.37363553047180176)  
destderrs: 'gfal-sum error: 2 (No such file or directory) - HTTP 404 : File...  
destsums: None

**Deletion  
Average Time**

$$\text{ExpectedTimeUK} = (40 / 60) + \text{BUFFER} = 2.6667 \text{ s}$$

$$\text{ExpectedTimeNonUK} = (40 / 120) + \text{BUFFER} = 2.333 \text{ s}$$



# Benefits of Pre-deployment Testing:

- Make sure basic functionality works
- Benchmark the performance of copy/deletion on endpoint
- **See how change in configuration affects performance**

The screenshot displays two test results in a table. The first row, #30, shows a test named 'test\_deletion[https:CEPH-SVC16-tst.txt]' with a green checkmark, a duration of 0s, and a refresh icon. A tooltip points to the refresh icon with the text 'Status changed after retry'. The second row, #29, shows a similar test with a green checkmark and a duration of 0s. The table is partially obscured by a vertical bar on the right side.

✓ #30	test_deletion[https:CEPH-SVC16-tst.txt]	(0, 'https://ceph-svc16.gridpp.rl.ac.uk:109...)	↻ 0s	Pa
✓ #29	test_deletion[davs:CEPH-SVC16-tst.txt]	(0, 'davs://ceph-svc16.gridpp.rl.ac.uk:1094...)	↻ 0s	cmc des

# Conclusion:

- Framework provides a pre-deployment testing solution for XRootD endpoints
  - It is easy to use and configure, and versatile
- Benchmarking results help ensure endpoints are ready for deployment
  - GitHub: <https://github.com/stfc/xrootd-testing-framework>



Science and  
Technology  
Facilities Council

# Thank you



Science and Technology Facilities Council



@STFC\_matters



Science and Technology Facilities Council