XKIT:

XRootD Kubernetes Integration Testing

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Intro

- Slightly packed set of slides.

- Unfortunately, must leave early today.

  Very happy to discuss any of this further by email:
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- We're looking for some input/wisdom from the experts to improve this ☺

  Please tell me if/when I'm wrong.

Site History – Edinburgh Tier2 Version

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- ??? - 2018: Ran DPM at our site which eventually migrated to dCache.
- 2021 – 2022: Gained experience(s) testing XRootD-PFC internally for (ATLAS) grid workflows.
- 2022 – 2023: DDOS'ed our own storage several times due to mis-configuration.
- 2022 – 2023: Had a student work to optimize our cache performance.
- 2023: Turned off our dCache ahead of CO7 EOL.
- 2024+ : Contributing to wider UK storage efforts which mostly use XRootD.

Setting the Scene

- Larger UK grid sites use XRootD in different ways. (See Alastair's Talk)
- 5 large Tier2 site configs, all similar, but none the same.
- Supporting different users, different release versions, different plugins combinations, ...

  e.g: v4 client <-> v5 server using vector reads

  vs: 3rd party copy v5 <-> dCache ...

- Question that has come up in testing:

"What was the *'golden'* release/plugin version which worked for user X?"

UK Grid Software Deployments

1. Grid site performs an install, does simple tests, possibly with a small test queue.
2. Local & Remote VO experts check that everything is working as expected.
3. Ideally, small problems then involve 3-4 people who may not be low-level experts.
4. Issues impacting users tend to involve more people, take more effort ...

- Want to reduce person-power/effort needed to verify new packages for production configurations.
- Virtual site deployments which ‘look like’ real-world sites reduces effort needed for **2.**

Motivations for XRootD Integration Testing

<u>My opinion:</u> similar situation to when I worked on another grid project Ganga.

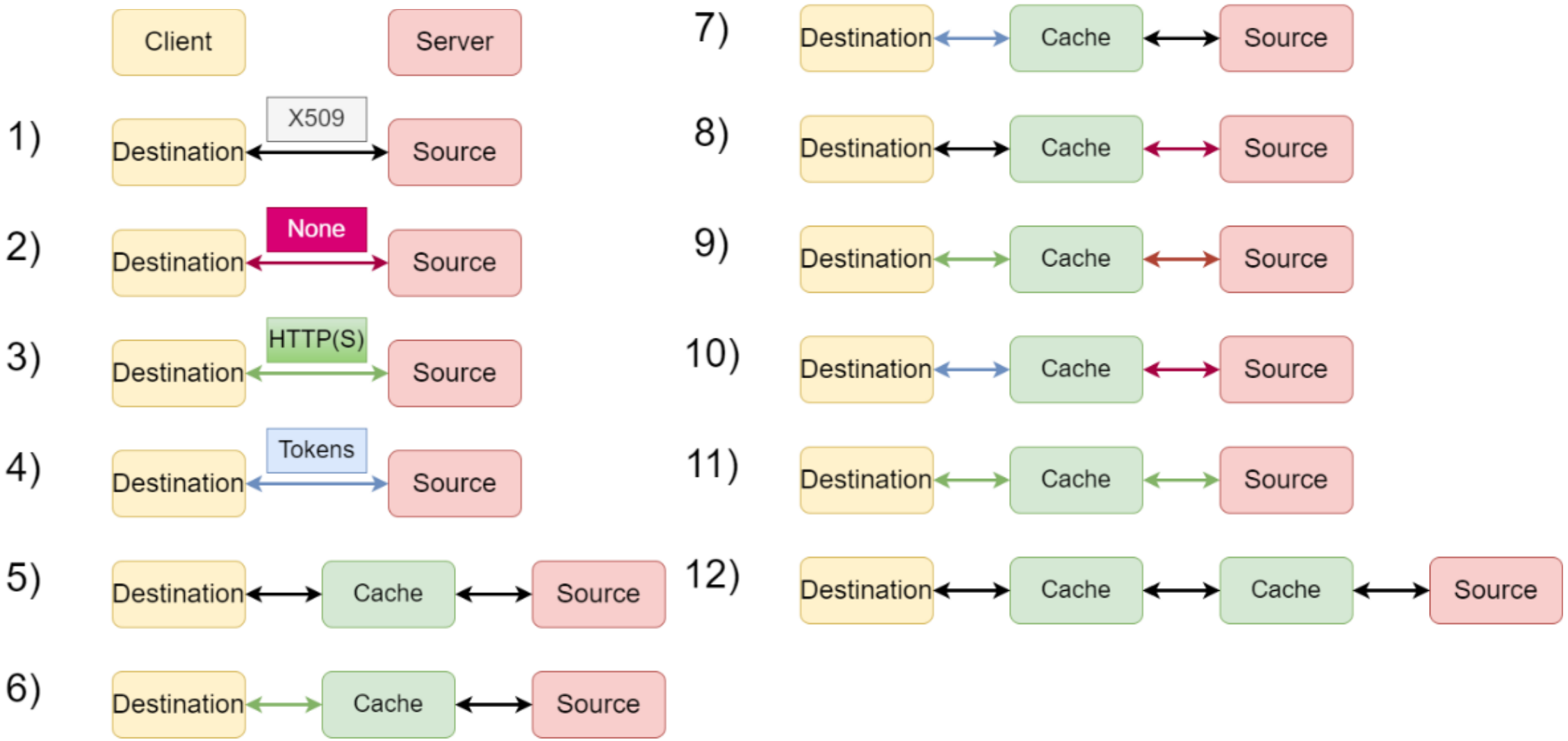
- **Unit-testing != Code Analysis != Integration Testing**

1. Large tool with large codebase & many uses.
2. Many communities using it to solve their problems.
3. Works extremely well.
4. Highly configurable with many plugins.
5. Not every community is running bleeding edge clients/versions.
   (some communities are better than others)

- Testing is difficult because the phase-space is so large.

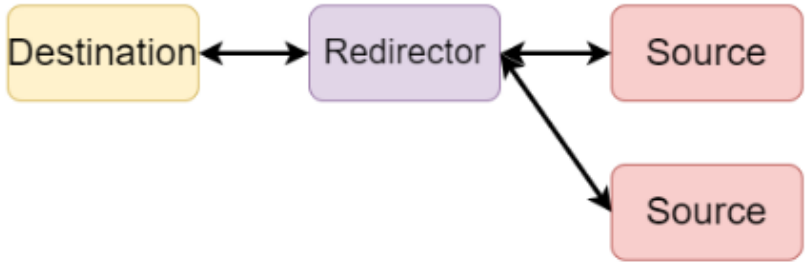
> 3 large dimensions; client version, server version & network topology
> many compact dimensions, plugins options, server options, expected pass/fail

How much do we want to test?



How much do we want to test?

13)



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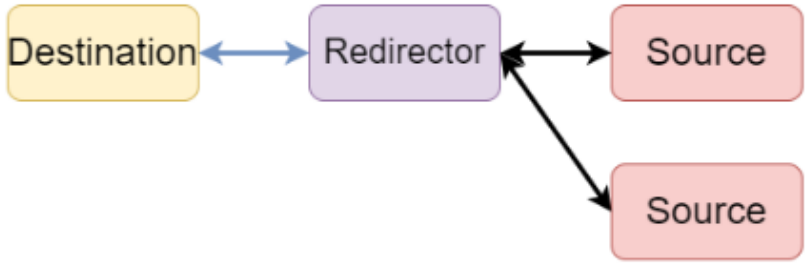

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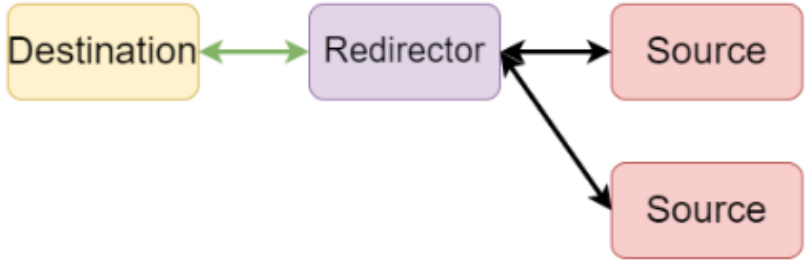

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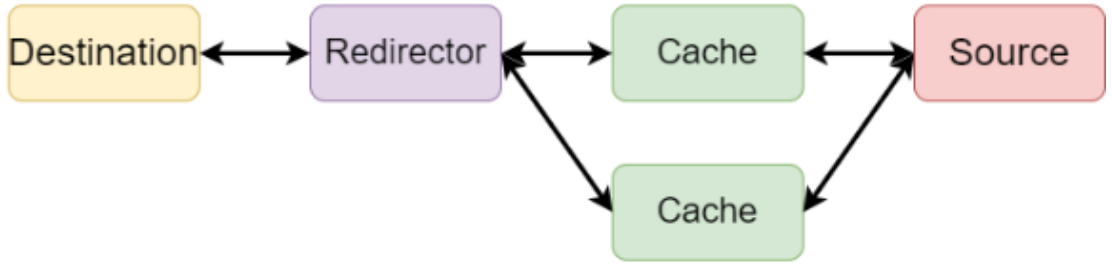

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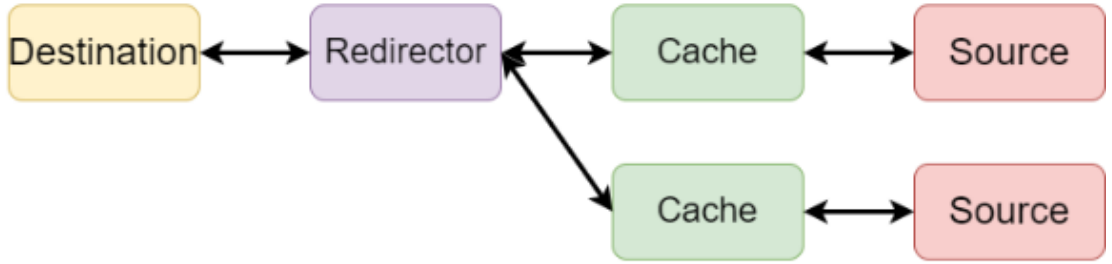

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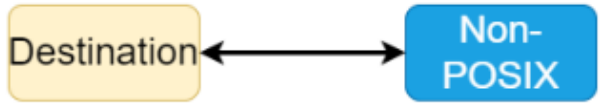

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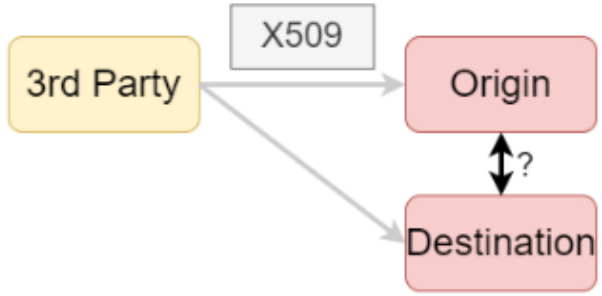
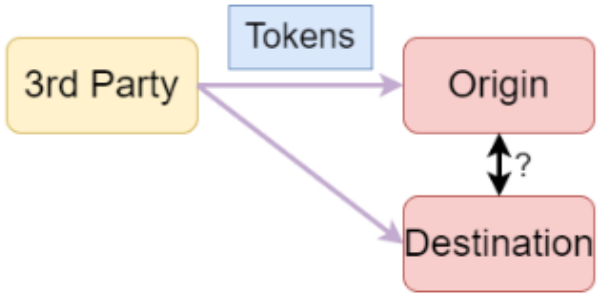
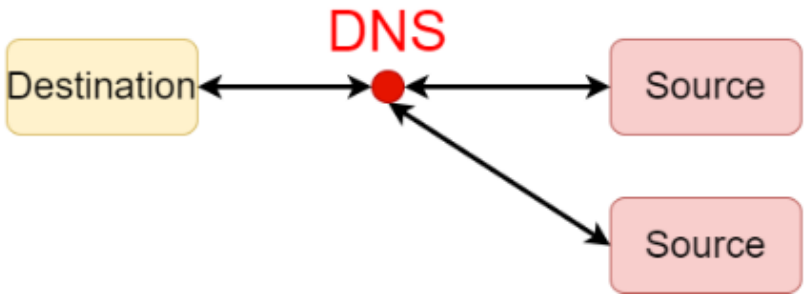


How much do we want to test?

20)



21)



The topology of a “typical XRootD install” seems to vary within UK.

Would be good to try and identify the key components of this.

Want to test/check/know-how-to-use all features and best practice(s).

Test Management

- **XRootD** Integration Testing requires 2 parts:

Client:

→ Test cmdline tools (xrdcp, xrdfs, ...)
→ Test Python3 client API(s)
→ Double-check everything works as expected
→ Might aim test the C++ API (something closer to user-code in HEP)

Server:

→ Want to verify server behaviour (logs/output)
→ Want to test read/write transfers work as expected
→ Check server-side features configs haven't changed

Containers to the Rescue!

XRootD is already used in Containers

- **But we want a minimal container for testing!**
- Container design often ends up optimizing for 1 of 2 goals:

- **Deployability**: *

Container design used by **perfSonar**, **Gitlab…**
Deploying several services within a single container.
Not-so-great for seeing what's going on, debugging, or fixing/testing…

- **Reproducibility**:

This is what you see in more commercially supported containers.
Closer to the UNIX philosophy of **<u>"do one thing and do it well"</u>**
Minimal, **great for testing**.

* Yes, I just made up a word…

XRootD Package/Image Management

IF someone else is doing a better job we can use their base images(!).

- Why is this important? Containers are backed by images;

We are now '***rolling our own***' container-images:

1. Using the **rpm** build recipe from the XRootD github repo (standing on the shoulders of giants!)
2. Built rpms from source on Alma9 base image(s)
3. Packages installed via dnf with all *normal* extensions for XRootD and dependencies
4. Image is tagged with release version
5. New images published to dockerhub
6. **No security/configuration/gremlins baked into images**

Deploying these containers means we have additional runtime control how we mount in CRL/config/data/cute-cuddly-kittens from our host into the container.

Service Management

~~Container Orchestration~~

- OK, now we have an image, so can launch containers/run-tests.

- We **started with docker-compose** to manage multiple services.
- **This ended quickly**.

- When setting up a single transfer of:

  POSIX → PFC → Destination DNS gets annoying

- Docker/Podman(-compose) aren't friendly to mocking real world security setups.

This is a shame; we're making use of docker-compose a LOT at our site.

Service Management

Let’s fix the problem of complex container management, with… more containers!

Container Management

- Each XRootD instance needs:

  → CRL/VOMS mounted/updated from host
  → Config mounted from host
  → Test data mounted from host *
  → DNS entries pointing to instance
  → Hostcert mounted from host (per-instance)
  → External network connectivity

- Just like a thousand people before us; **go with Kubernetes**

*So far, biggest use-case is POSIX, but plan to test CEPH-FS

“There’s an API for that!”

- Almost everything “speaks” Python3 these days.

  (The less we code, *the less we debug*, trying to keep things minimal)

- **Kubernetes**, **Docker**, **S3**, **OpenSearch**, **Django**, ...

- Most of the ‘*heavy lifting*’ for projects like this has been done for us.

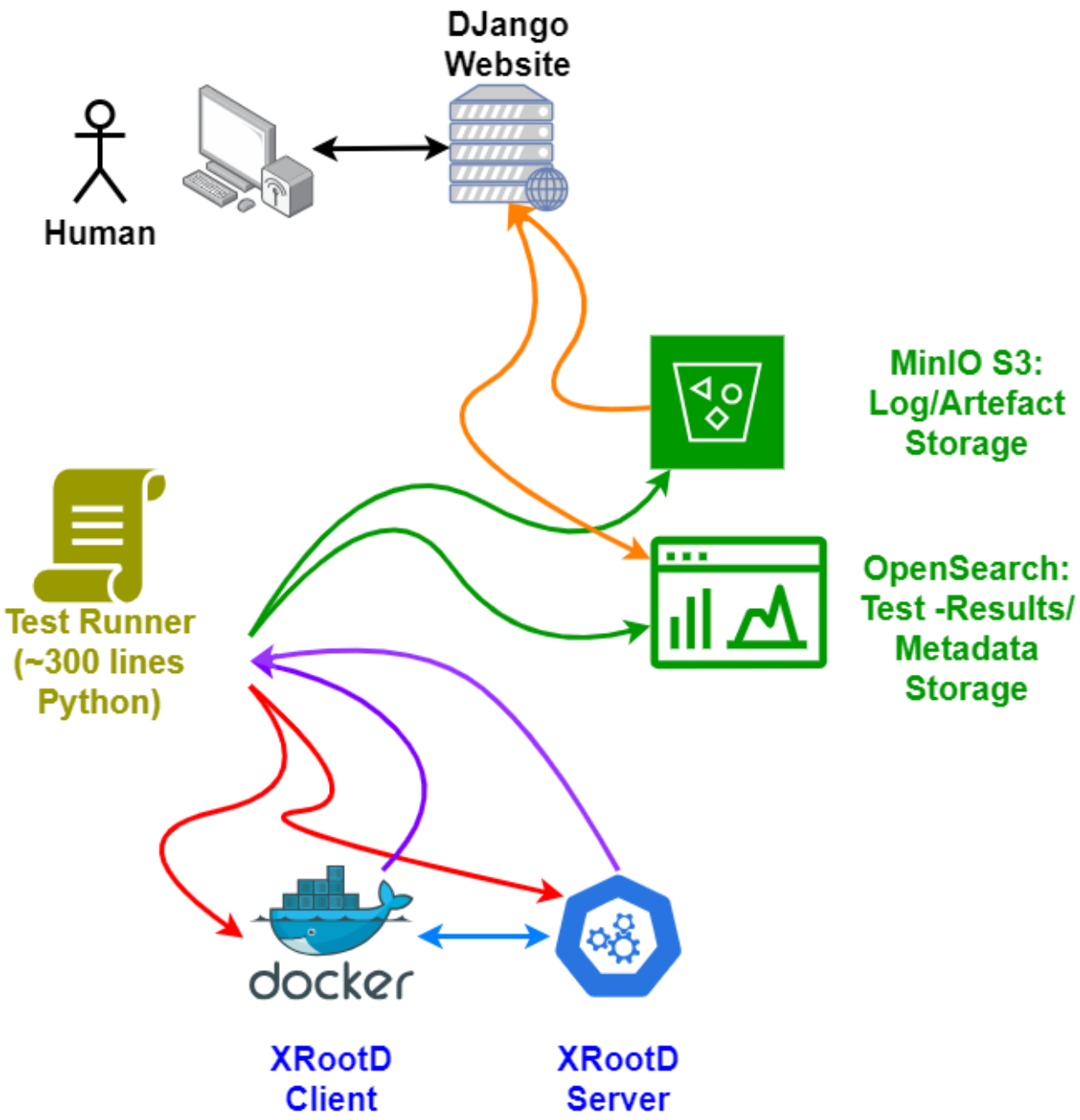
- With that in mind, we decided to start working out what to do.

- Not *all work* is in Python3... but most of it.

Running Tests

The Plan...

Testing Strategy
1) Deploy Configuration and Launch Containers
2) Wait for tests to run
3) Collect container artefacts
4) Store Test Results/Logs
4) Display Results to User



What do we have so far?

XRootD CI test results

localhost:8000/display_table/

XRootD Test Results

client_image	server_image	client_output	server_output	testTime	testName	testStatus	@timestamp
gridppedi/xrdtesting:xrd-v5.7.0	gridppedi/xrdtesting:xrd-v5.7.0	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_clientOutput.log	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_serverOutput.log	2024-07-22T15:40:36.595529	read.py	GOOD	2024-07-22T15:40:36.595820
gridppedi/xrdtesting:xrd-v5.7.0	gridppedi/xrdtesting:xrd-v5.7.0	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_clientOutput.log	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_serverOutput.log	2024-07-22T15:31:27.728273	read.py	GOOD	2024-07-22T15:31:27.728584
gridppedi/xrdtesting:xrd-v5.7.0	gridppedi/xrdtesting:xrd-v5.7.0	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_clientOutput.log	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_serverOutput.log	2024-07-22T15:32:48.912504	read.py	GOOD	2024-07-22T15:32:48.912898
gridppedi/xrdtesting:xrd-v5.7.0	gridppedi/xrdtesting:xrd-v5.7.0	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_clientOutput.log	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_serverOutput.log	2024-07-22T15:35:25.426305	read.py	GOOD	2024-07-22T15:35:25.426606
gridppedi/xrdtesting:xrd-v5.7.0	gridppedi/xrdtesting:xrd-v5.7.0	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_clientOutput.log	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_serverOutput.log	2024-07-22T15:40:20.524026	read.py	GOOD	2024-07-22T15:40:20.524350
gridppedi/xrdtesting:xrd-v5.7.0	gridppedi/xrdtesting:xrd-v5.7.0	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_clientOutput.log	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_serverOutput.log	2024-07-22T15:46:49.528588	read.py	GOOD	2024-07-22T15:46:49.528985
gridppedi/xrdtesting:xrd-v5.7.0	gridppedi/xrdtesting:xrd-v5.7.0	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_clientOutput.log	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_serverOutput.log	2024-07-22T15:51:34.707189	read.py	BAD	2024-07-22T15:51:34.707649

What do we have so far?

(Not bad for <100 lines of Python!)

Containers on DockerHub

Test Client & Server logfiles on (*private*!) S3

Test Metadata, success/fail, timestamps, ...

XRootD CI test results

localhost:8000/display_table/

XRootD Test Results

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gridppedi/xrdtesting:xrd-v5.7.0	gridppedi/xrdtesting:xrd-v5.7.0	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_clientOutput.log	pythonTestOutputs/read.py_C_xrd-v5.7.0_S_xrd-5.6.2_serverOutput.log	2024-07-22T15:51:34.707189	read.py	BAD	2024-07-22T15:51:34.70764

What do we have so far?

- Simple, ***entirely dynamically generated*** web-UI.

  Not ***yet*** public, plan to '~~*hide*~~' host behind an OAuth login.

- Using a github organization for managing the various pieces of this: https://github.com/gridpp-Edi

- **Tests repo:**

  https://github.com/gridpp-Edi/xrootd-ci-tests

- **Server configs repo:**

  https://github.com/gridpp-Edi/xrootd-helm-charts

(Still empty as of ~~August~~ September 2024 ☹ aiming for uploading tests before CHEP)

Just starting to populate this repo for testing ☺

Tier2 Site Perspective

From the Site's Perspective

- This has ***lots*** of moving parts (*and only 2 fractional admins*):

  DNS, VOMS, Kubernetes, multiple new systems to update/maintain, S3, OpenSearch/ElasticSearch, message queues, credentials...

- Slight concern:

  Did we just replace effort required for one piece of work with more effort required for somewhere else?...

- All these services are being re-used by some other project.

  Not just throwing up lots of services for a single goal.

From the Site’s Perspective

- Work on this allows us to:

1. Support the in-development protoDUNE DAQ offline monitoring
2. Support DUNE-DM monitoring
3. Support GridPP-FTS monitoring
4. Support UoE PPE-Labs clean-room certification
5. Gain valuable experience with Kubernetes
6. Supporting GridPP UK Storage efforts

Conclusions

Conclusions

- Successfully run initial tests against XRootD using our ‘pipeline’.
  - Data transfers in/out of ‘Virtual site’ using containers.
- Have worked out most of the annoying bits in setting this up.
- Have a minimal web-UI which we aim to share ASAP.

Conclusions – Next Steps

- Need to expand our testing topology (helm charts).
  - So far have server-side configs for simple XRD-POSIX and XRD-PFC.
  - Only testing X509 auth but want to do more.
- Need to flesh out some additional tests.
  - Successfully written/read data from POSIX via different API.
  - Want to automatically test 3rd-party copy between endpoints, internal and external.
- Plan to integrate with higher-level testing system for tracking different client/server tests and outputs.


THANK YOU FOR
LISTENING