Using dCache Storage Events in NextCloud and On-Site Experiments

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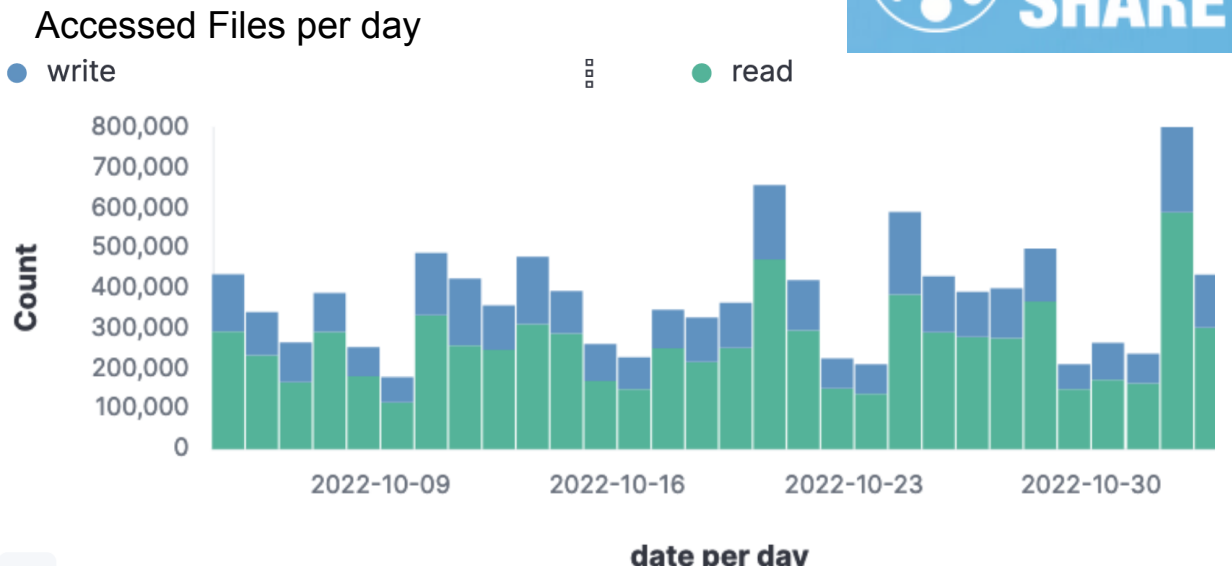
DESY.

Motivation

Why do We Need Storage Events

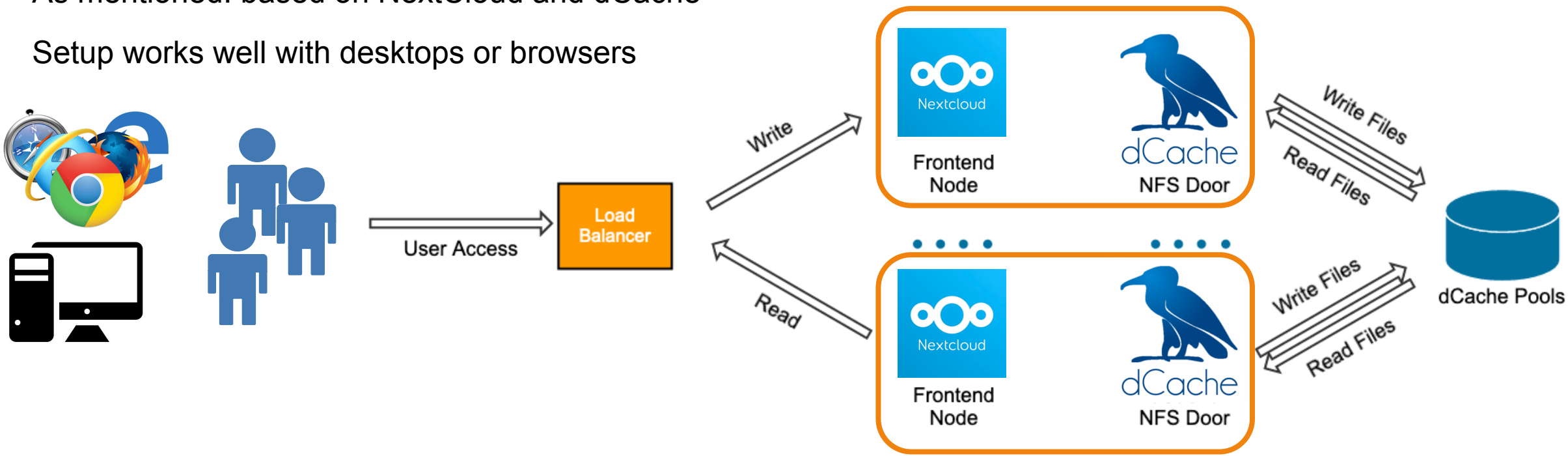
- Sync&Share service based on NextCloud increases in popularity at DESY
- Running regular dCache and NextCloud versions
- See increased pure scientific use-cases
  “Take a look at my training results from today”
- Find a way to integrate into our cluster infrastructure
- Deployment of NextCloud Sync-Client suboptimal on a shell based environment
  → Desktop design (GUI heavy)/CLI limited functionality
  → Tedious configuration in SSH login shell
- Cause unnecessary traffic and space usage (syncing your talks/reports to the cluster)
- Make use of our backend storage: dCache



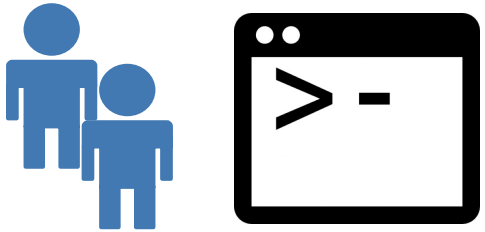
DESY Sync&Share

Service Overview

- As mentioned: based on NextCloud and dCache
- Setup works well with desktops or browsers



- How to fit in access from compute clusters?



How to Access Sync&Share without Using NextCloud

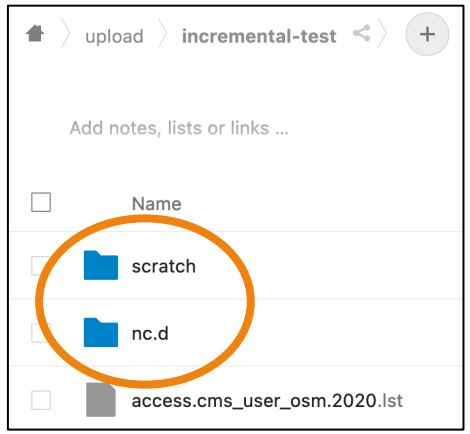
Use dCache directly

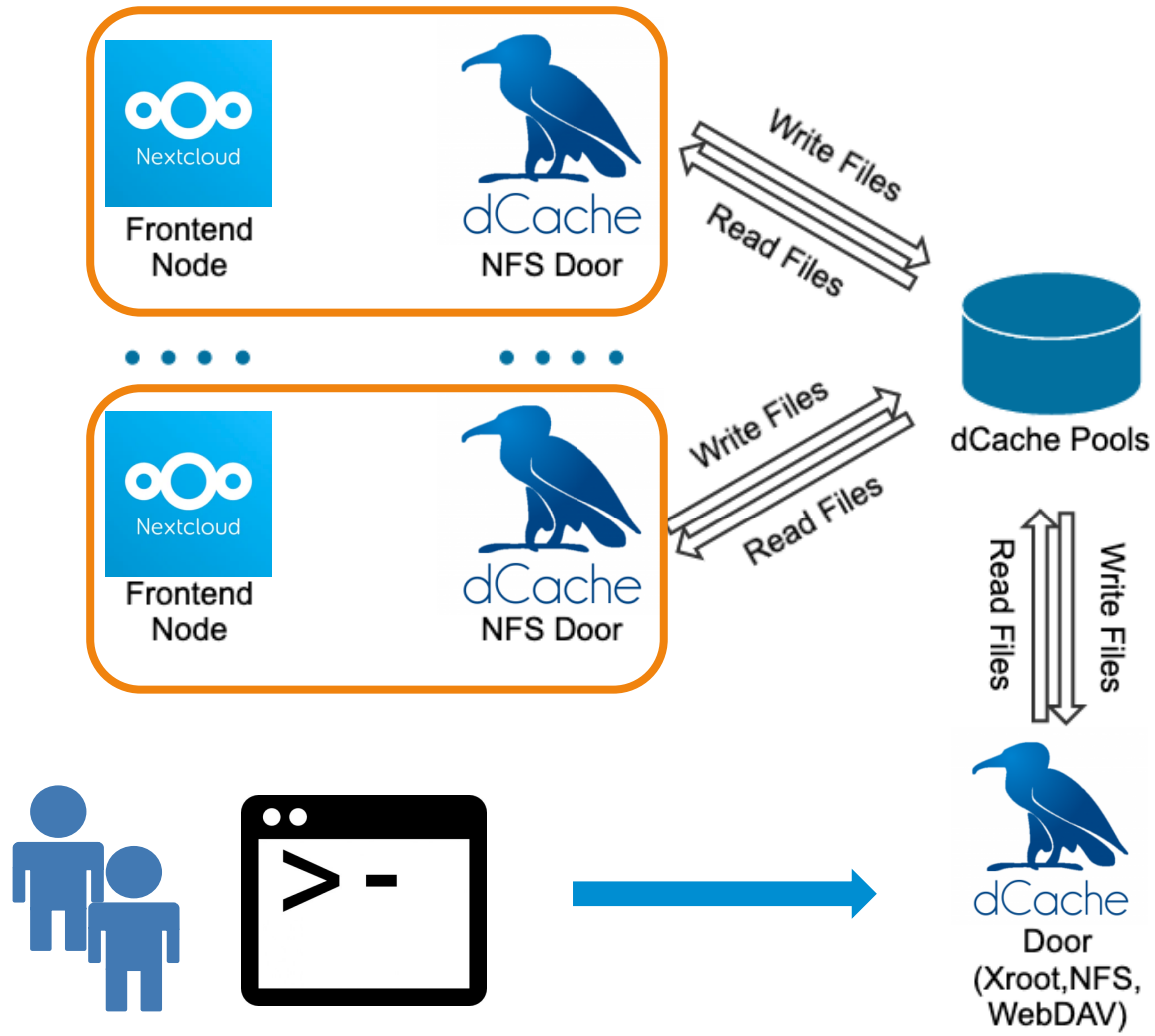
- Instead of using the sync-client → write/read directly from dCache
- Naively: Introduce regular dCache endpoints

Read Access

- Straight forward
- NextCloud namespace reflected 1 to 1 in dCache
- Configures namespace to carry correct `uid:gid`

```
[vossc@naf-it01] vossc $ rclone lsd cloud-dcache:/vossc\/files/upl
oad/incremental-test
          -1 2022-11-01 13:35:20        -1 accesslist_per_month
          -1 2022-11-01 13:35:17        -1 accesslist_per_protocol
          -1 2022-11-01 13:19:57        -1 nc.d
          -1 2022-11-01 13:19:57        -1 scratch
```





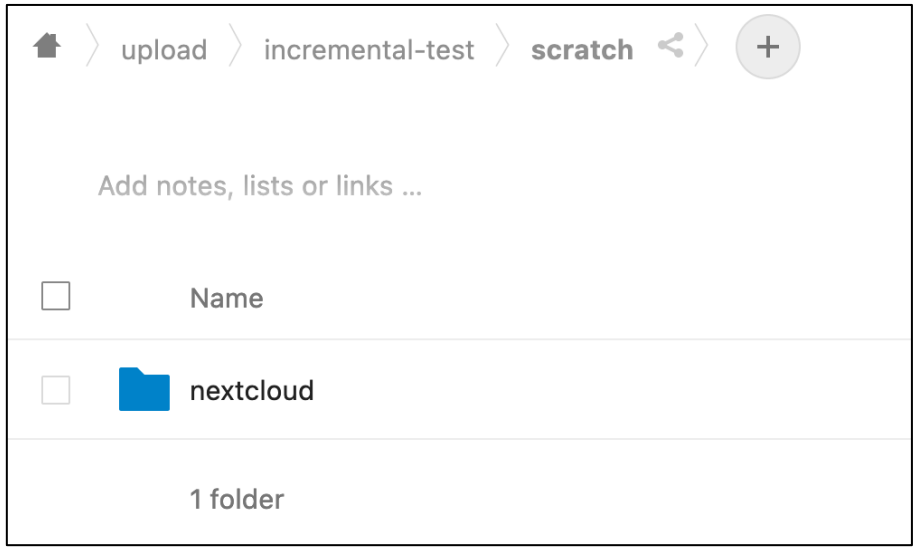
Writing through dCache to Sync&Share

View from Command Line Clients

Write Access

- Should be straight forward as well
- NextCloud namespace reflected 1 to 1 in dCache
- Configures namespace to carry correct `uid:gid`
- Use our client to write a file

```
[vossc@naf-it01] tmp $ rclone copy --max-depth 1 --include "dcache-8.1.6-1.noarch.rpm" . cloud-dcache:/vossc/files/upload/incremental-test/scratch/
[vossc@naf-it01] tmp $ rclone ls --max-depth 1 cloud-dcache:/vossc/files/upload/incremental-test/scratch
129278835 dcache-8.1.6-1.noarch.rpm
```



The View from NextCloud

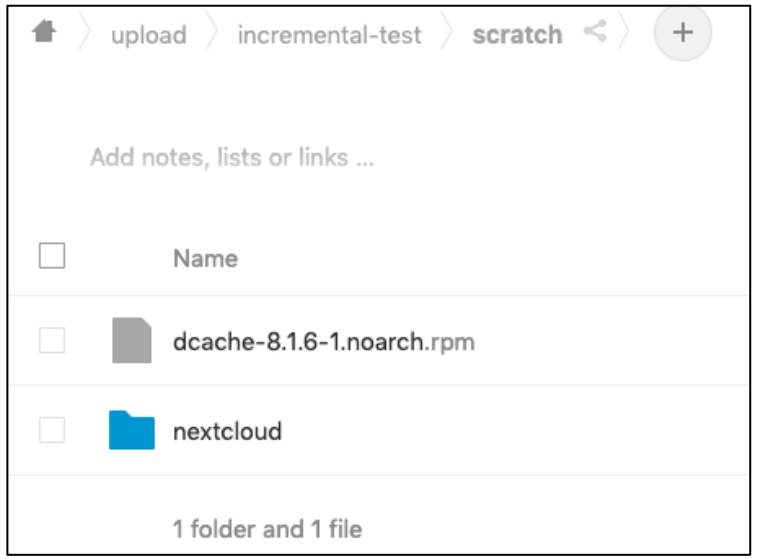
How to Register Files

What Happened?

- We have produced dark data for NextCloud → need to perform a scan

```
[root@it-sas-management ~]# sudo -u apache php /var/www/nextcloud/occ files:scan --path "vossc/files/upload/incremental-test/scratch"
Starting scan for user 1 out of 1 (vossc)
+---------+-------+--------------+
| Folders | Files | Elapsed time |
+---------+-------+--------------+
| 45      | 1     | 00:00:01     |
+---------+-------+--------------+
```

- After the scan the file is visible:



How can we automate this?

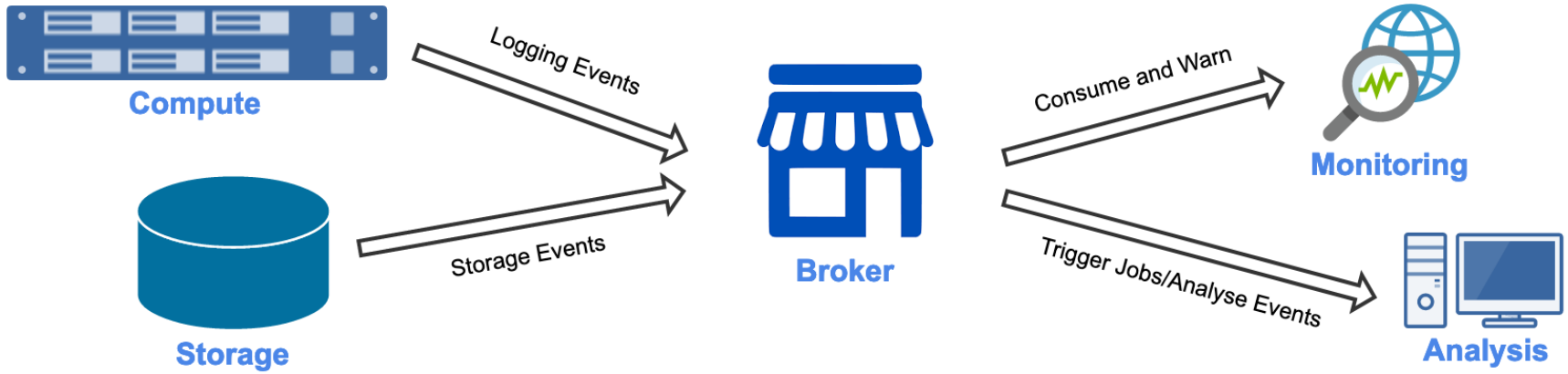
- Cronjob per day/hour → latency too large
- All 3k user directories? → time intensive
- Use dCache storage events

Messages and Events

Arbitrary Definitions for Upcoming Slides

- Event act similar announcements to interested consumers (marketplace)
- Not directed to a specific endpoint (e.g. sending a direct call to a specific service)

- **Message Producer – Broker – Consumer Model**



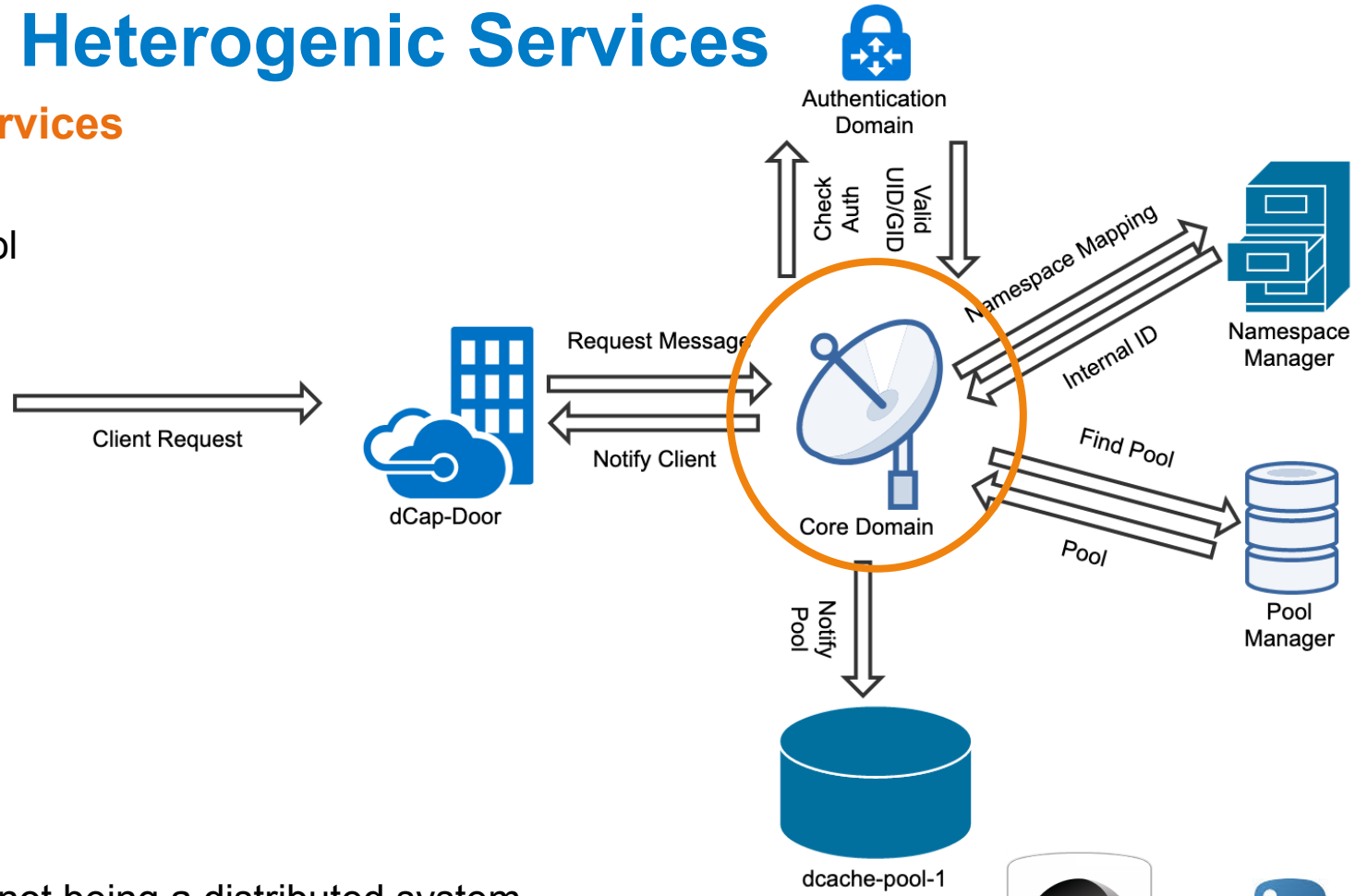
Define two categories of events

- Event itself contains all data: e.g. **Logging Events**
  → Consumer itself can perform data analysis
- Event points to data: e.g. **Storage Events**
  → Consumer needs to interface with the data or tools analysing the data

Communication between Heterogenic Services

Connecting Different and Independent Services

- Based on Micro-Services (1 service 1 task)
  - `Doors` – supporting each a different protocol
  - `Heads` – pool selection, Namespace, Auth
  - `Pools` – data storage and server



- Central Domain in dCache handling messages
- Usage of native Java object serialisation (JOS)
- Message hub internal to dCache

How can we apply this to our workflows

- Often employ a collection of 3rd party software:
  - 3rd party tools act as micro-services despite not being a distributed system
  - No message service → Employ specialised messaging tools
  - No unified internal messaging format → Use universal standards e.g. JSON
  - Make workflow message aware → Use universal bindings to messaging tools

python™

kafka

Make Our Sync&Share Event-Aware

Trigger the NextCloud File-Scan whenever a File is Written

- Connecting the dots → use events to register each new file automatically

Message Producer

- Offers a message stream by default
  → no need to develop a message producer
- Message stream is Kafka based

Notify

File written

Message Broker

kafka

- Widely used tool in industry
- Comes with bindings for all common languages
- A lot of tool can connect directly to Kafka
- Cope with high data rates
- Retains memory about last consumed messages

Consume &

Register File

Message Consumer

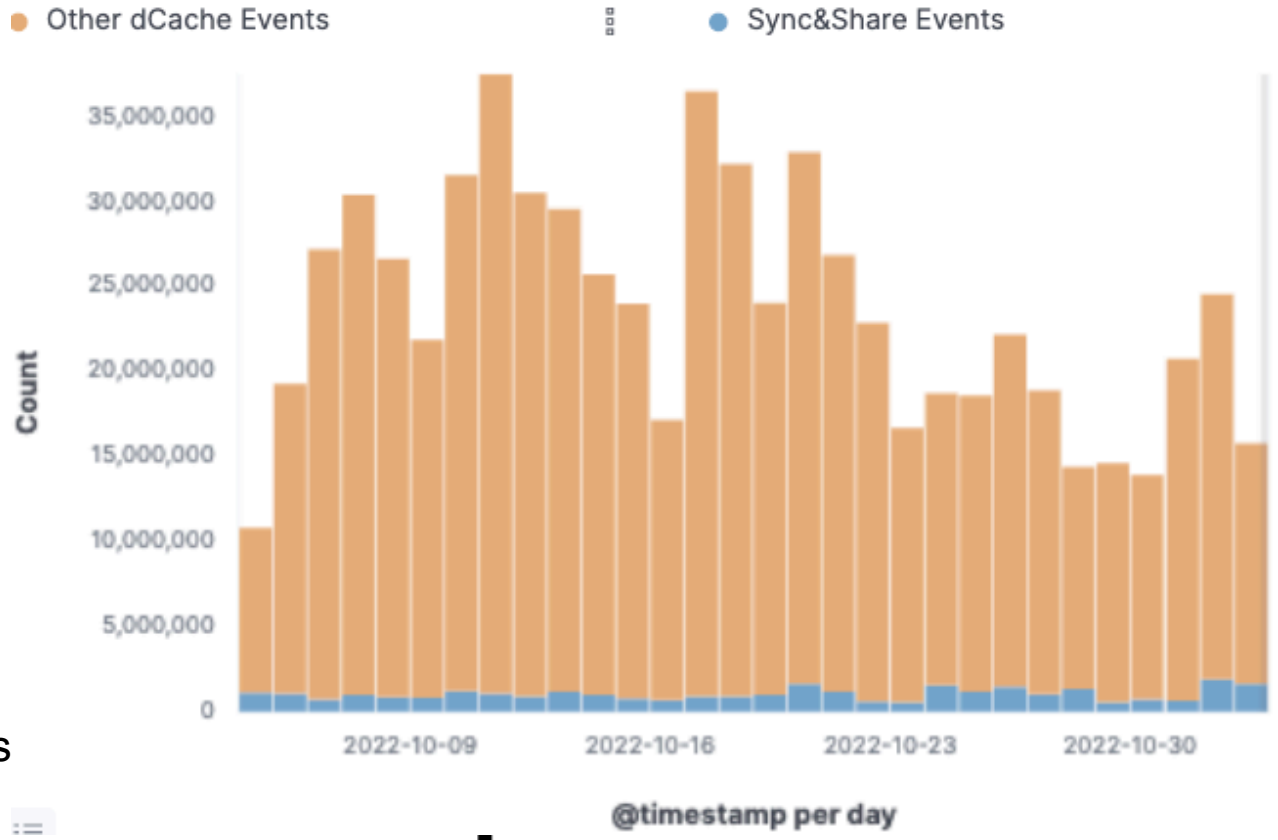
Nextcloud

- Unfortunately not message aware
  → need to develop a Kafka consumer to register files in NextCloud

Custom Consumer

dCache Operations Kafka Infrastructure

Number of Storage Events per Day



- Cluster of 5 nodes, incl. their Zookeeper cluster
- Average 15M events per day(small S&S contribution)
- Use one topic per instance
  → reduces number events we need to analyse

- Strong support from industry software
- Established as message broker with prominent customers
- Monitoring tools easily pluggable with Kafka
- Data analysis platforms can consume and analyse streams directly ⟶ Online data analysis
- Open API for Kafka for custom producers/consumers

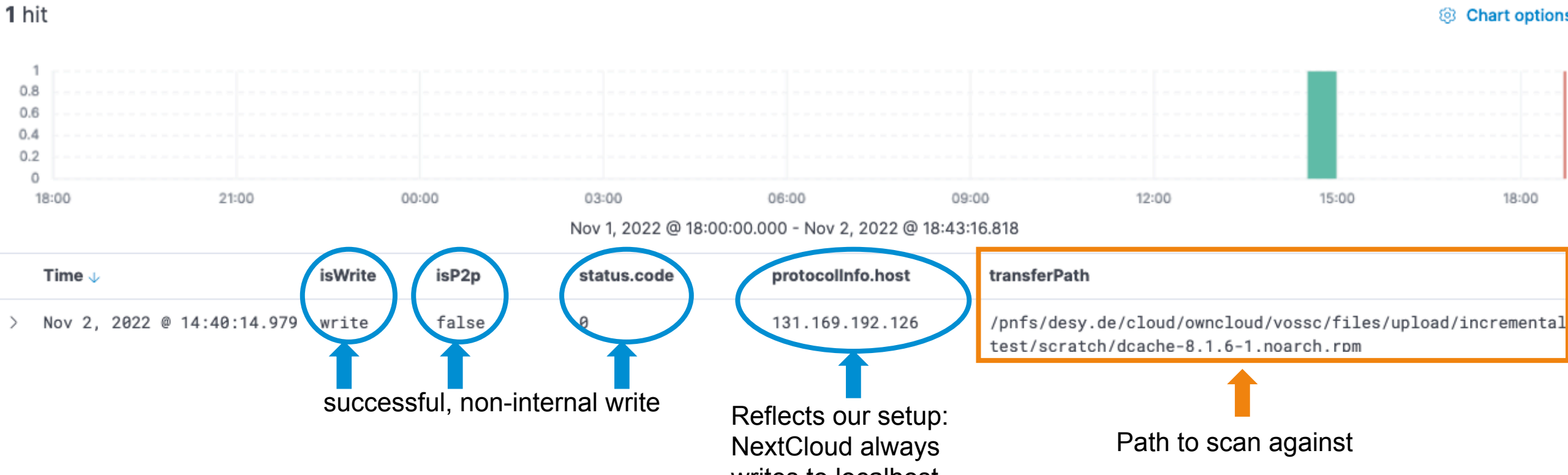
Custom Consumer

Custom producer

How to Find the Uploads in the Event Stream

Use a Custom Consumer

- Almost all accesses are made through NextCloud → allows to write a simple filter



successful, non-internal write

Reflects our setup: NextCloud always writes to localhost

Path to scan against

Adding the Consumer

Use Kafka Bindings to Trigger the Scans

python™

- NextCloud cannot evaluate the storage events → write a custom consumer
- Use the python bindings (easy to install via pip)
- Depends on Kafka-wrapper classes written by us
- Pluggable Kafka-consumer using a object of type `DOTKafkaMessageAnalyser`
- Deploy as SystemD-service on management node (due to necessary permissions)

Execute for every event

Filter selection

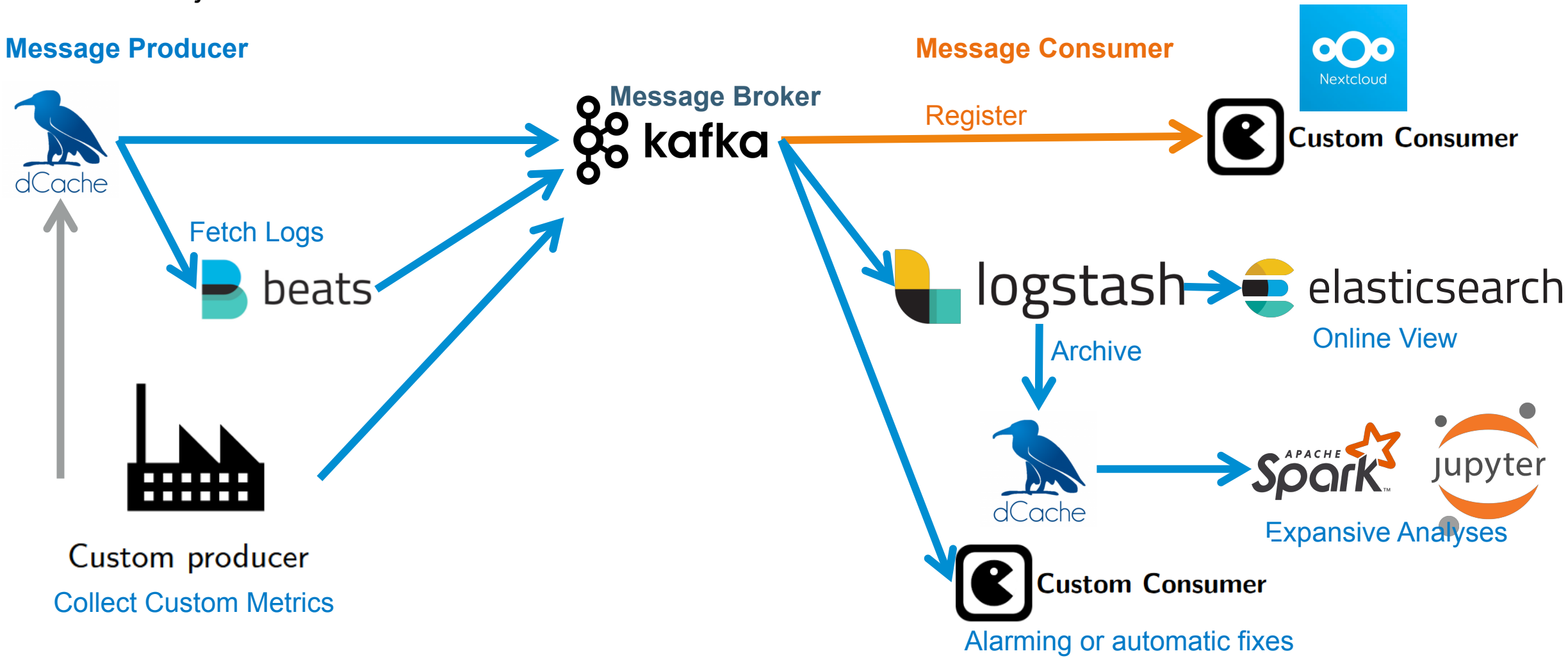
Trigger the scan

```
class ScanOnArrival(DOTKafkaMessageAnalyser):
    def __init__(self, instance = '', listenPath = '/', verbose = False) :
        self.instance = instance
        self.listenPath = listenPath
        self.verbose = verbose

    def execute_shell(self, command=''):
        systemcall = subprocess.Popen(command, stdout=subprocess.PIPE, stderr=subprocess.PIPE, shell=True)
        log, logerr = systemcall.communicate()
        return log

    def execute(self, message):
        message_data = message.value

        if message_data.get('msgType', None) == 'request' and \
           message_data.get('client',None) != '127.0.0.1' and \
           message_data.get('moverInfo',{}).get('isP2p', None) == False and \
           message_data.get('moverInfo', {}).get('isWrite', None) == 'write' and \
           message_data.get('moverInfo', {}).get('status',{}).get('code', None) == 0 and \
           self.listenPath in  message_data.get('transferPath',None):
            print("File: {} - written from {}; requires file-scan in NextCloud)".format(message_data.get('transferPath',None),
                                                                                        message_data.get('client', None)
                                                                                        ))
            file_scan_cmd = 'sudo -u apache php /var/www/nextcloud/occ files:scan --path "{}"'.format(scan_path)
            scan_log = self.execute_shell(command=file_scan_cmd)

            if self.verbose :
                print(scan_log)
```

The Larger Picture – Connection to Other dCache Consumer

Context to Other Active Consumers of dCache Storage Events

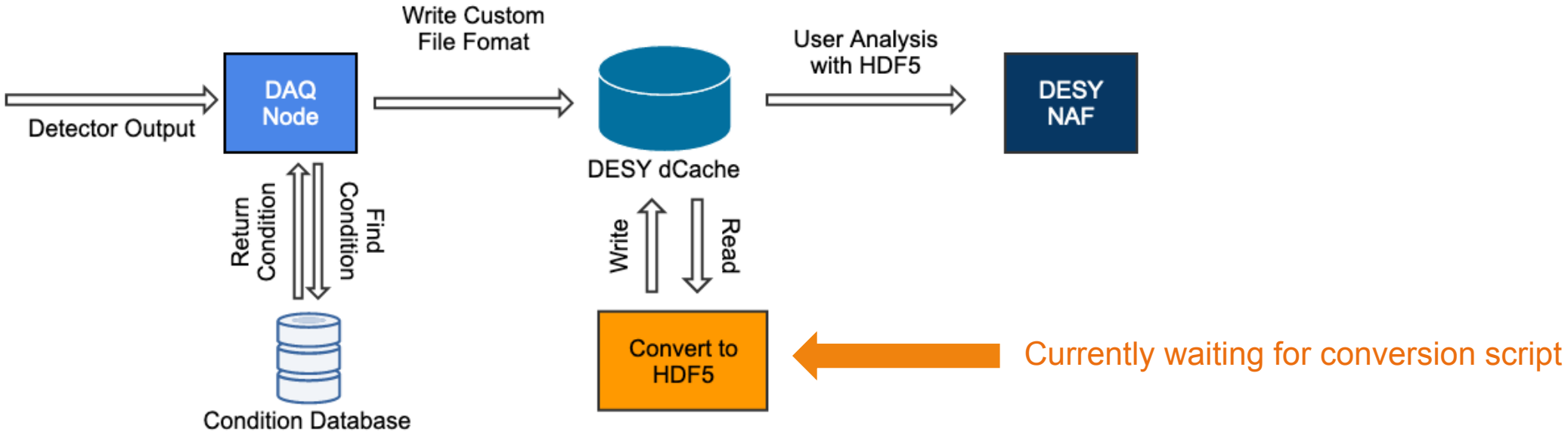
- NextCloud just another in our dCache infrastructure



Example for Similar Use case – ALPS II

Converting Custom Data Format to Default HDF5

- Next step: would other tasks profit from a similar workflow
- Existing similar work using Kafka events for PETRA 3 but method and Ansatz different to our solution
- Local experiment searching for Axions → write custom format but aim for HDF5 for user analysis



- New complication: permission to read/write data files → exists dedicated user to use together with NFS/POSIX ACLs
- Run regular batch jobs doing the conversion: ALPS scientists have limited experience there
- Our idea: put a similar service to NextCloud into production using NAF resources (details still to be discussed)

Scale-Out – Cloud Based Ansatz

Use Modern Tools Instead of Dedicated SystemD Service

- Described setup sounds familiar? → sounds like AWS Lambda; suited for Function as a Service workflow
- Our consumers are
  - Python Scripts
  - Containerised easily for a Kubernetes based deployment
  - Serverless: take Kafka message → manipulate/analyse → push on to next service
- Showstoppers:
  - Overall lack of experience in our dCache operations group
  - Some applications are not always serverless
    → NextCloud consumer needs be run on a NextCloud no
    → ALPS II use case needs permissions to r/w to dCache (currently based on NFS)
- Colleagues investigated these problems in the past: https://doi.org/10.5281/zenodo.3599569
- Handling of access tokens to dCache, HTCondor and FaaS service itself proved difficult
- Follow up on these in the future

Scale-Out – Spark and Workflow Management Systems

Managing Compute Intensive Consumer/Integration into Larger Infrastructure

- Currently our consumers are not CPU intensive → might change in the future
- ALPS II conversion might offer insight if we need more dedicated scale-out into our clusters

Possible Scale-out: Apache Spark

- Spark ships with Kafka streaming build in → collect 1k messages and then compute each in the cluster
- Adopted Spark in 2018 for our data analysis tasks; migrated certain Spark-jobs successfully as HTCondor Jobs on NAF
- Offer a start to think about dealing with CPU intensive tasks

Wider Picture: Make Use of Workflow Management Systems

- Instead of off-loading to Spark, why not offload to the batch systems on NAF directly
- Rather home-brewed setup → should easily be integrated into a more general service
- DESY lacks a dedicated Workflow Management System for us to integrate → might change in the future

Summary

Using dCache Kafka Storage Events with external Consumers

- Migrated DESY Sync&Share to regular dCache and NextCloud releases early in 2022
- Begin integrating NexCloud into our regular scientific infrastructure using dCache storage events and access protocols
- Build on our setup and development using Kafka messages for logging, accounting, monitoring and analytics for dCache

- Find our Workflows adaptable for certain scientific use cases for our local experiments
- Work remains to merge this into a modern setup using container-based setups like Kubernetes
- Merge our effort into a Workflow Management System once available

Thank you