SPD data management

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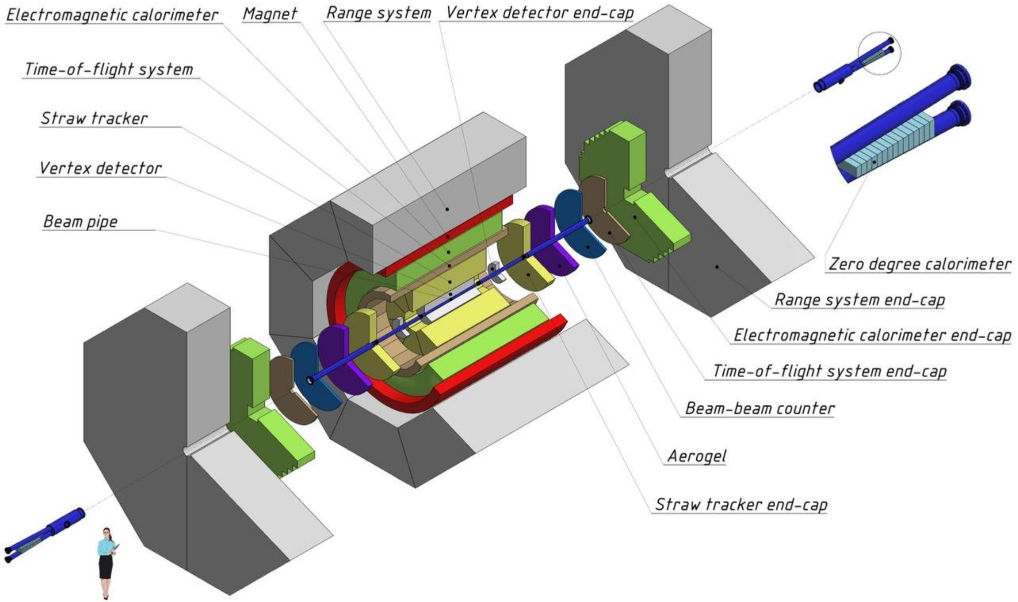
Spin Physics Detector (SPD)

The spin structure of the **nucleon** is one of the fundamental properties of matter. The spin of a nucleon is distributed between its components — **quarks** and **gluons**, and their mutual movement.

The EMC, HERMES, and COMPASS experiments have made it possible to study in detail the contribution of **quarks** to spin. However, the role of **gluons** remains poorly understood and requires further research.



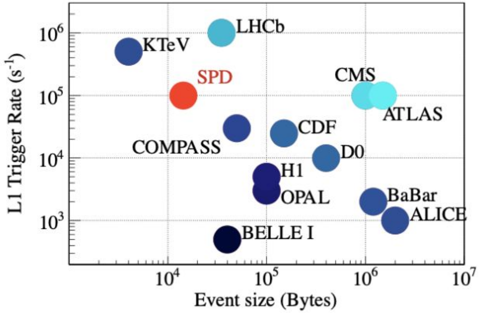
The SPD facility is being created for a more accurate study of the contribution of **gluons** to the spin of the **nucleon**.

SPD as data source

- Data from the detector – 20 GB/s (or 200 PB/year "raw" data, ~3*10^13 events/year)
- Simulation results – ??? (the exact volume is unknown, but it is comparable to the data volume from the detector.)
- Data of various intermediate formats along the way from “raw” to ready for analysis by physical groups – ??? (there will be a lot of them...)

The expected event rate of the SPD experiment is about 3 MHz (pp collisions at $\sqrt{s}$ = 27 GeV and 10^{32} $cm^{-2}s^{-1}$ design luminosity). This is equivalent to a raw data rate of 20 GB/s or 200 PB/year, assuming a detector duty cycle is 0.3, while the signal-to-background ratio is expected to be on the order of 10^{-5}. Taking into account the bunch-crossing rate of 12.5 MHz, one may conclude that pile-up probability cannot be neglected.

- SPD TDR



The goal of the online filter is at least to decrease the data rate by a factor of 20, so that the annual growth of data, including the simulated samples, stays within 10 PB. Then, data are transferred to the Tier-1 facility, where a full reconstruction takes place and the data is stored permanently. The data analysis and Monte-Carlo simulation will likely run at the remote computing centres (Tier-2s). Given the large data volume, a thorough optimization of the event model and performance of the reconstruction and simulation algorithms are necessary.

About Rucio

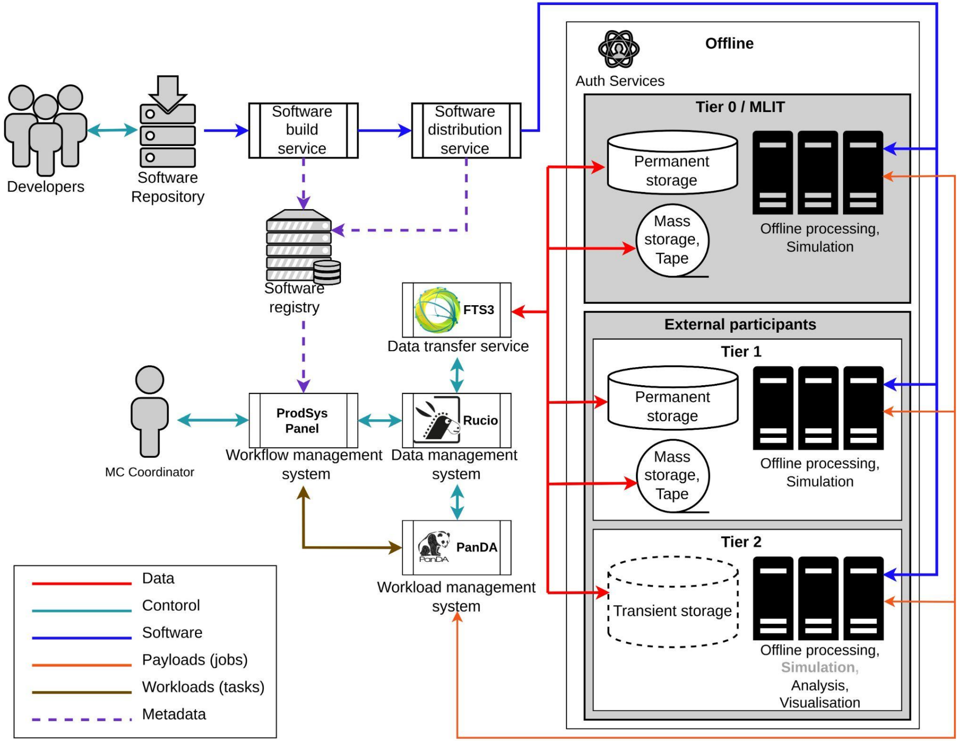
Rucio is an open-source software framework that provides functionality for data management and access in a distributed storage environment. Rucio organizes a single namespace, realizing the possibility of data management, interacting with the entire storage space as one. Rucio also provides protection against data loss and speed up access to data through a controlled number of replicas.

Rucio functionality

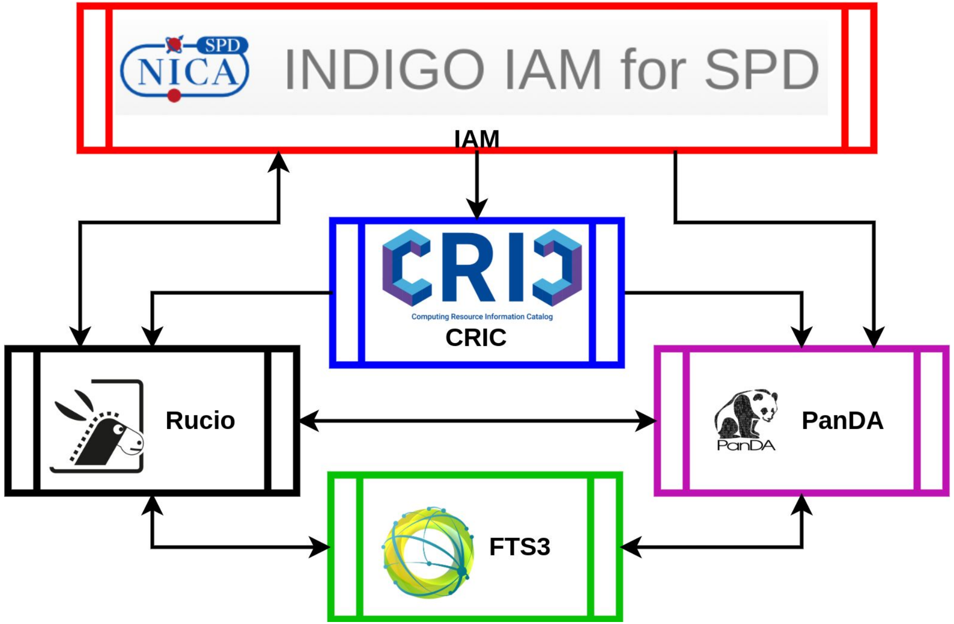
1. data catalogue;
   1.1. organize data in a hierarchical structure for easy navigation and management;
   1.2. storage of any types of experimental data;
   1.3. storage and management of metadata;
2. data lifecycle management;
3. unified interaction of a heterogeneous network and storage infrastructure (a resource catalog and data transfer service are required);
   3.1. adaptive data replication and recovery;
   3.2. automated data transfer between storages;
4. Exhaustive monitoring metrics: data usage, system performance, services health.

Starting point

- deploying all necessary components of Rucio
- figure out how it should work ;-)
- general configuration
- integration and testing interaction with PanDA
- integration and testing interaction with FTS
- integration with IAM
- integration with CRIC
- initial service monitoring



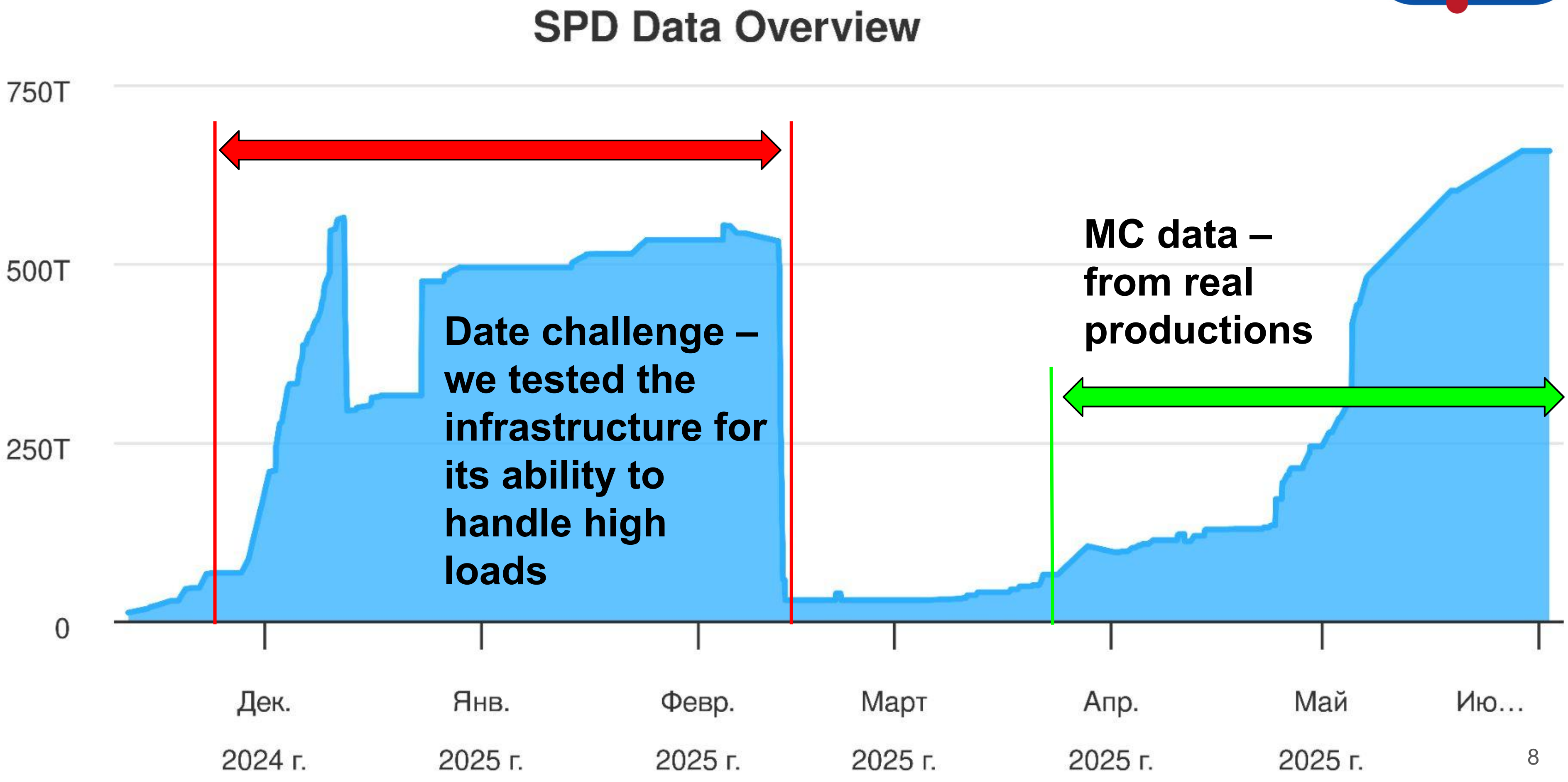
Structure of offline data processing system



- File Transfer Service 3 (FTS3) – a service for reliable and managed copying of large amounts of data between distributed storages.

- Identity and Access Management (IAM) – provides a layer where identities, enrollment, group membership and other attributes and authorization policies on distributed resources can be managed in an homogeneous way.
- Computing Resource Information Catalog (CRIC) – a system designed to manage and provide information about computing resources used in distributed computing infrastructures.
- Production and Distributed Analysis (PanDA) – a job management system designed for processing large amounts of data in distributed computing environments such as GRID.

Data Management [1/2]



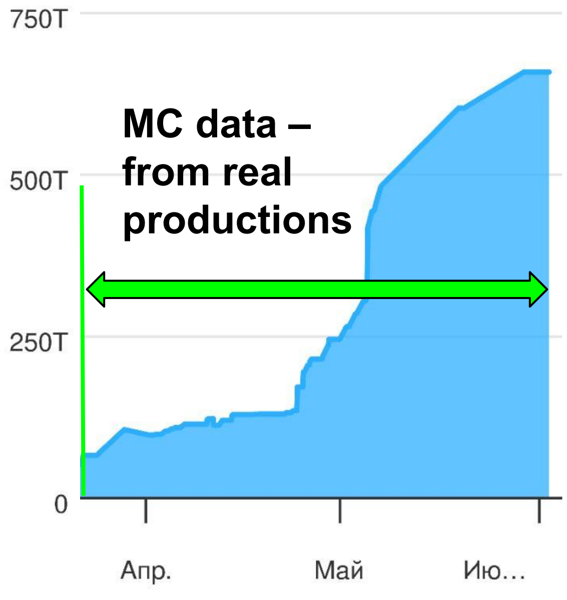
Date challenge – we tested the infrastructure for its ability to handle high loads

MC data – from real productions

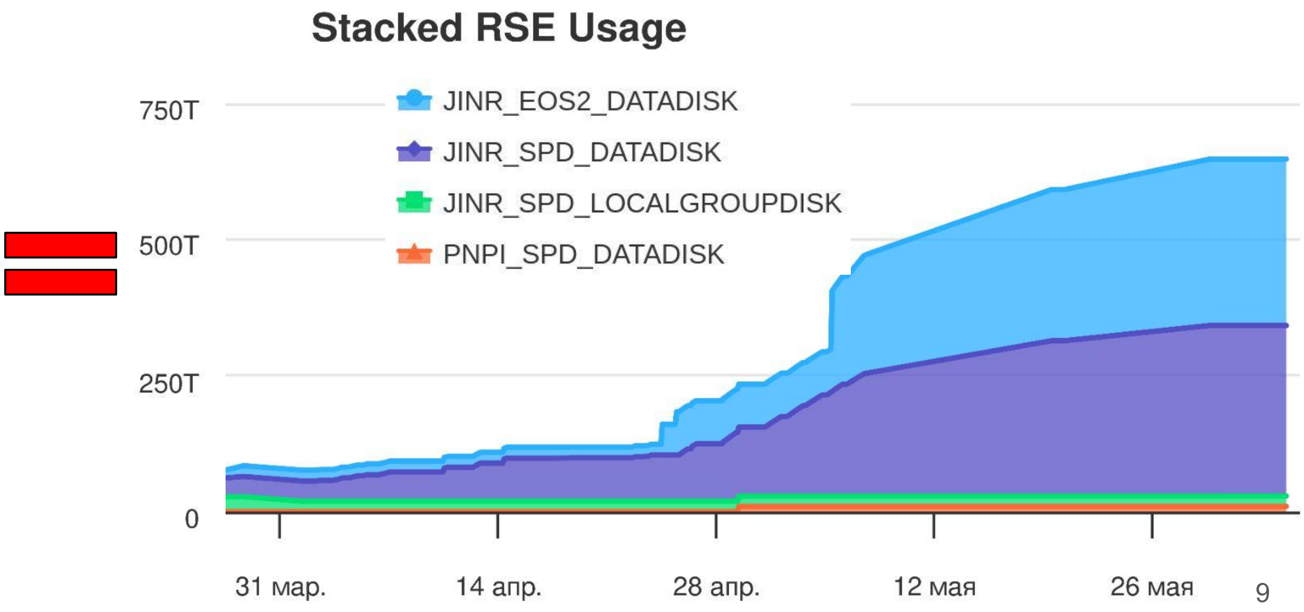
Data Management [2/2]

We have several storage facilities:

- **SPD EOS**: Since this year, SPD has own EOS in JINR and we are now transferring data from the old to the new one.
- JINR EOS: **DATADISK** – for production data generation, **LOCALGROUPDISK** – is used for results of test data productions.
- **PNPI EOS**: It currently stores a bit of data. It will be used to store replicas.



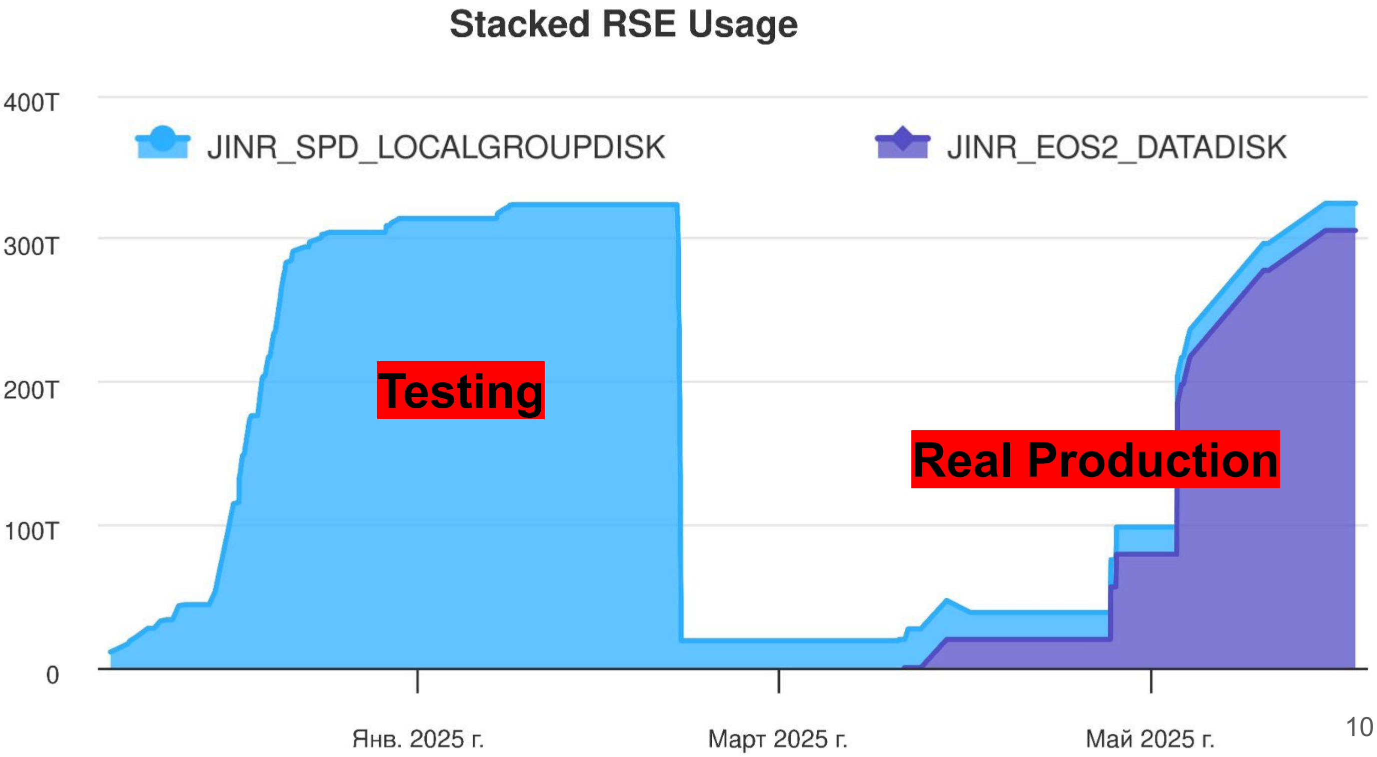
MC data – from real productions



Stacked RSE Usage

PanDA integration[1/2]

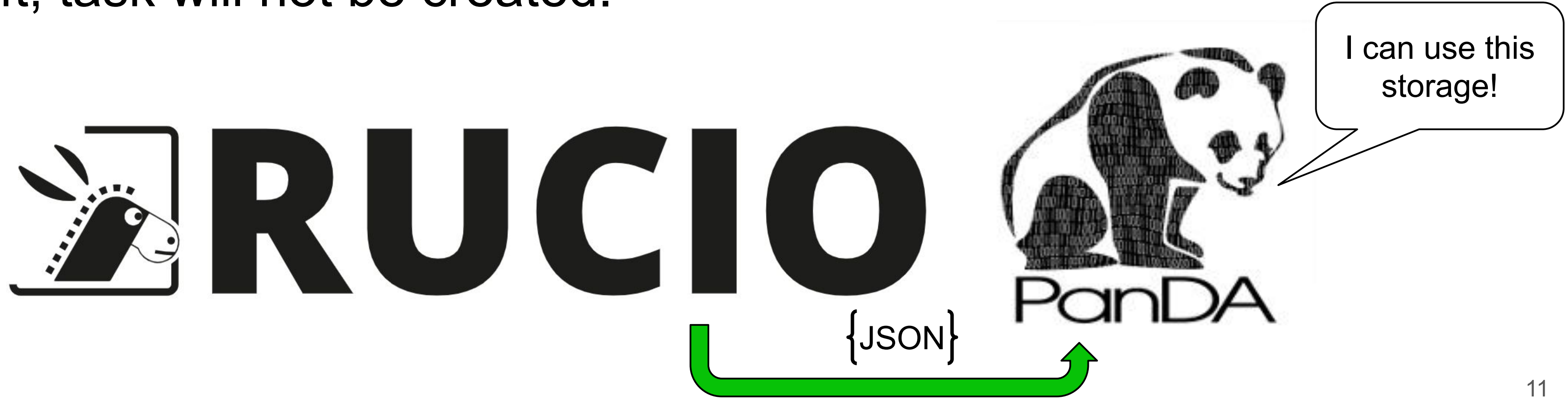
Currently, Rucio is used for mass production of SPD. During production, we tested interaction of PanDA and Rucio in various forms as well as different data organisation.



PanDA integration[2/2]

Special utility which informs PanDA about storages space usage was developed.

PanDA finds out about the storages space usage from Rucio. If the estimated task output size is larger than the storage space left, task will not be created.



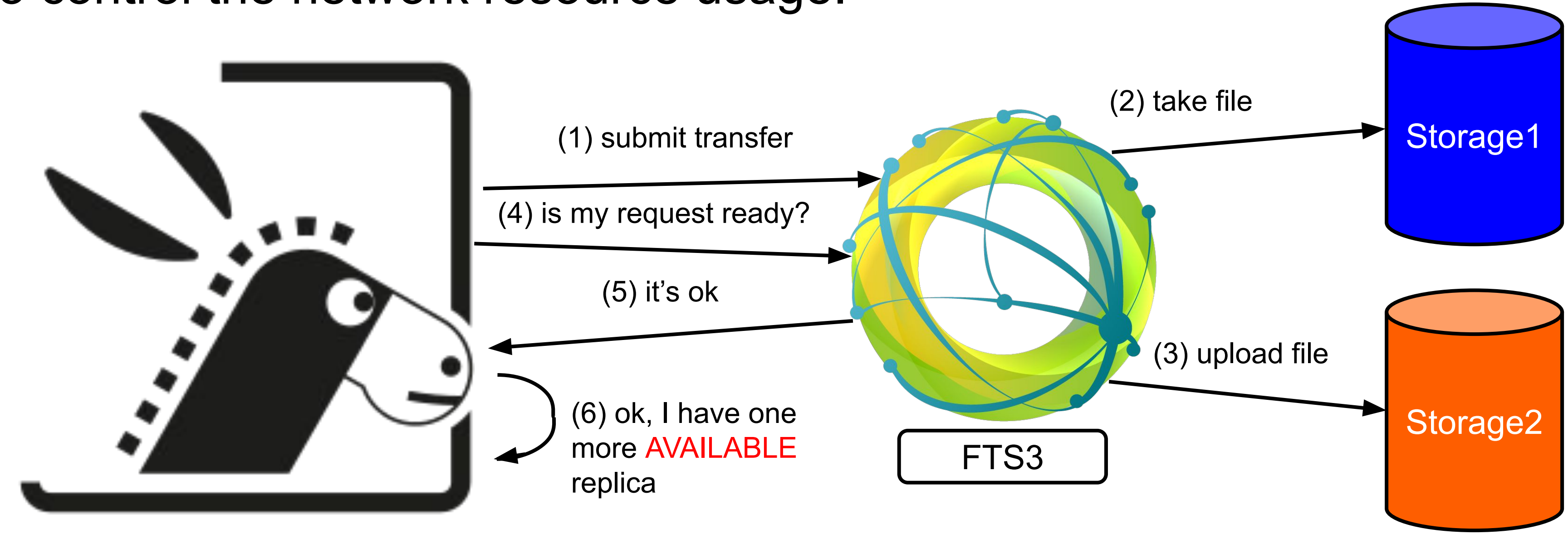
I can use this storage!

{JSON}

FTS3 integration

File Transfer Service 3 (FTS3) – a service for reliable and managed copying of large amounts of data between distributed storages.

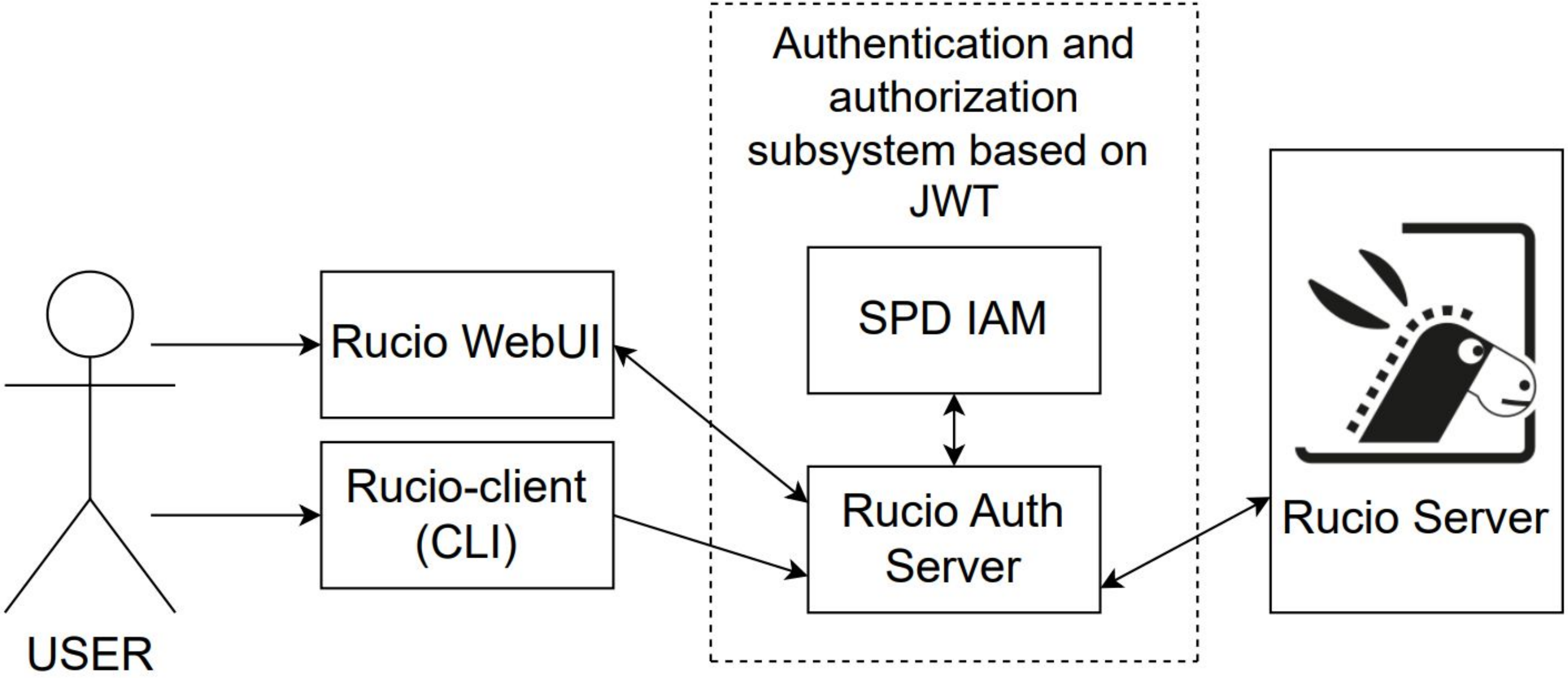
Is a low level data movement service, responsible for reliable bulk transfer of files from one site to another while allowing participating sites to control the network resource usage.



Integration with the SPD IAM [1/2]

Identity and Access Management (IAM) allows you to log in to a third-party application or system using an access token and an ID token obtained during authorization in IAM.

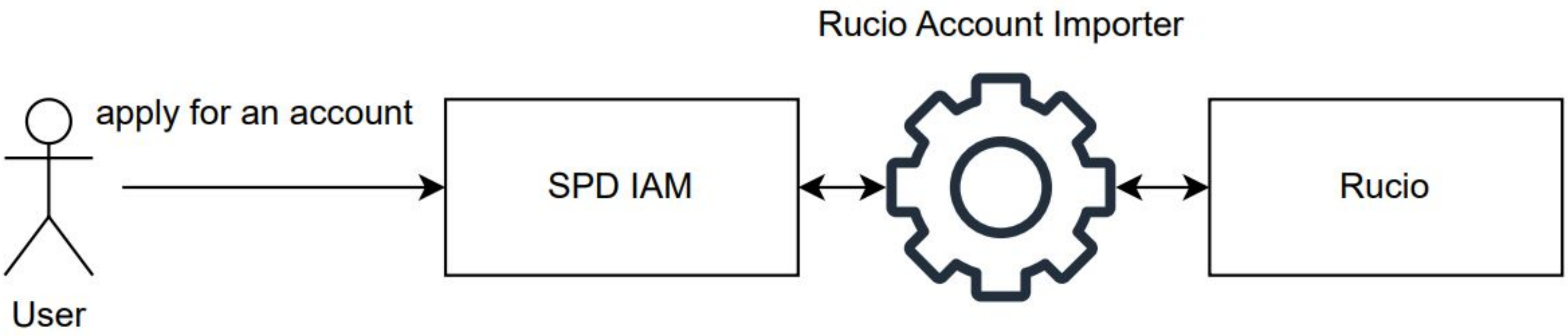
SPD IAM provides authentication to all services and systems (including Rucio). In the foreseeable future, each member of the collaboration will be registered there and will use this system to log in to other systems and applications (this will be used as a single entry point to the entire infrastructure).



Integration with the SPD IAM [1/2]

Special utility that imports **user** and **group** accounts from SPD IAM to Rucio was developed. This solution simplifies the access control process.

The Rucio Account Importer is configured to run in cron once per day. The utility adds new accounts and updates the identification information of existing Rucio accounts.



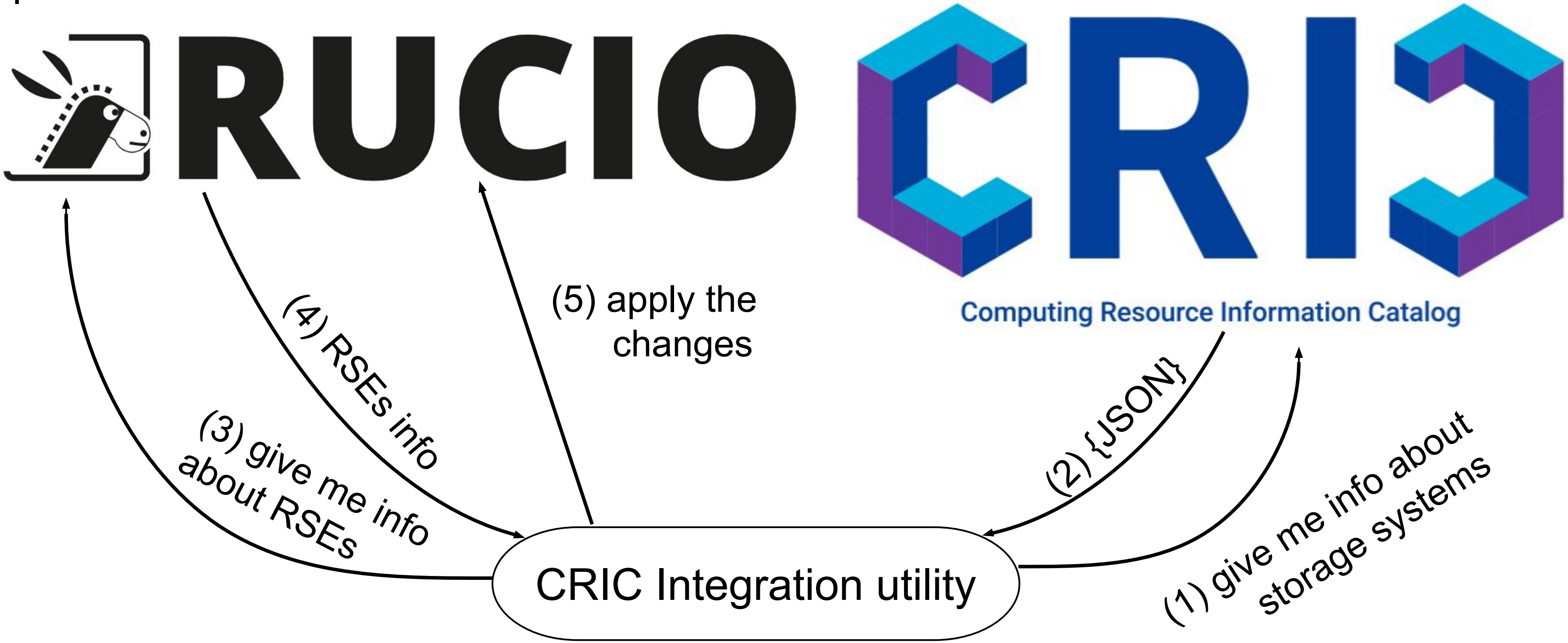
CRIC integration [1/2]

The Computing Resource Information Catalog (CRIC) is a system designed to manage and provide information about computing resources used in distributed computing infrastructures.

CRIC is integrated with Rucio to manage storage system configuration from a single location, by an administrator.

CRIC integration [2/2]

A module has been developed for importing configuration information about storage systems from CRIC to Rucio. This utility is configured to run in cron once per hour.



RUCIO

CRIC

Computing Resource Information Catalog

(1) give me info about storage systems

(2) {JSON}

(3) give me info about RSEs

(4) RSEs info

(5) apply the changes

CRIC Integration utility

Future plans

- Monitoring system – monitoring system to monitor the state of the system and its performance, as well as user activity and storages status.
- Development of a lifetime model and user policy.

Thank you for your attention!

Backup slides

Quick terminology recap

File – the smallest operational unit of data in Rucio.

Dataset – a named set of files.

Container – a named set of datasets or, recursively, containers

DID – rucio LFN for data (file/dataset/container) as combination of a scope and a name.

Scope – a scope partitions the namespace into several sub namespaces.

Replica – a managed copy of a file.

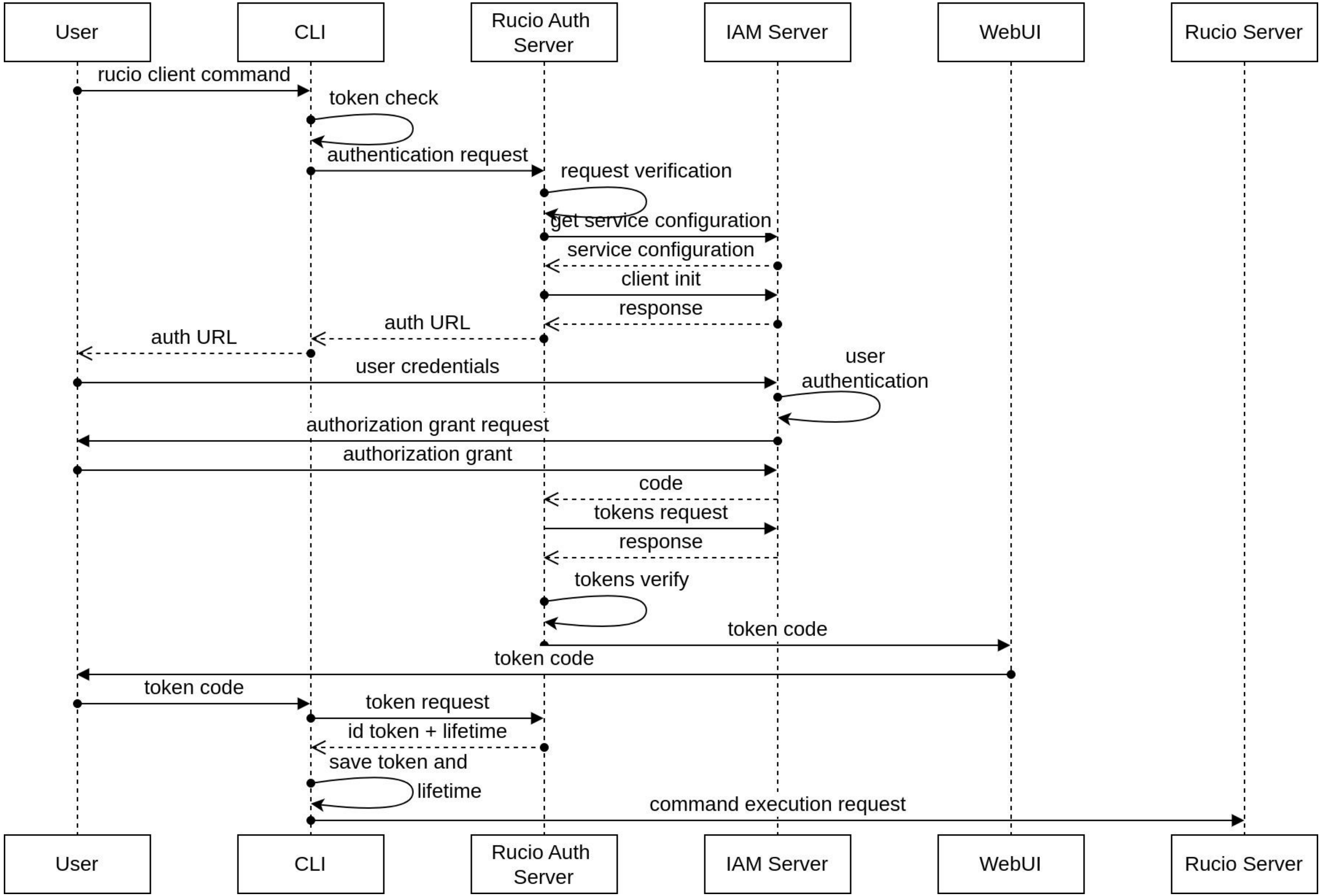
RSE – the logical abstraction of a storage system for physical files. It has a unique identifier and a set of meta attributes describing properties.

Current status

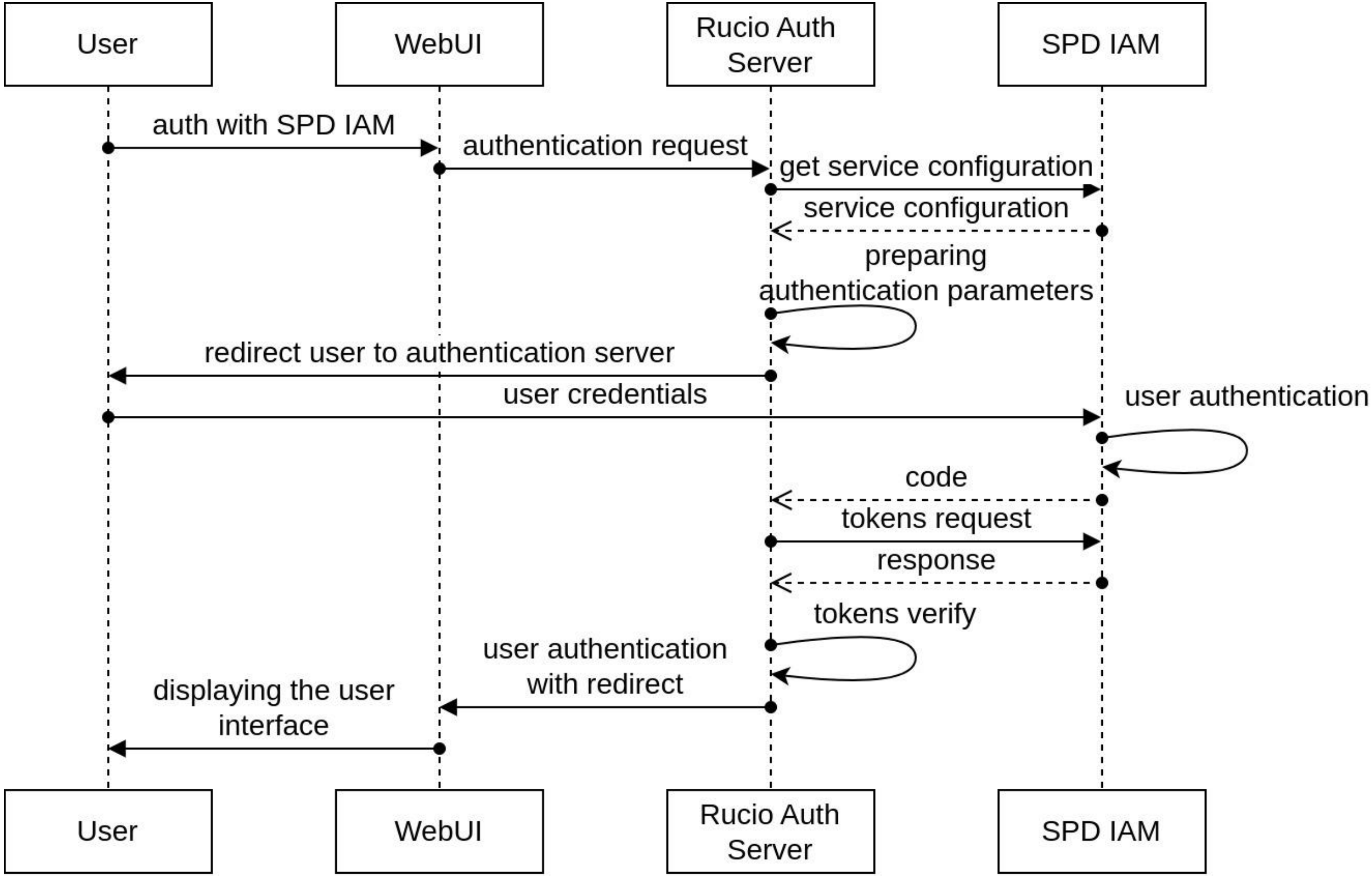
At the moment, the required set of system components of three Rucio-servers are deployed in Docker containers based on JINR cloud computing infrastructure:

- Prod Rucio-server. The main Rucio-server which work stable and used for the needs of the SPD collaboration.
- Dev Rucio-server. This server is used for development, testing and debugging.
- Int Rucio-server. All updates and innovations are checked and tested on this installation before being put on the Prod Rucio-server.

Authentication flow with IAM (CLI)



Authentication flow with IAM (Rucio WebUI)



Rucio Account Importer [1/3]

Rucio Account Importer is designed to import accounts from SPD IAM to Rucio and also to adding identities to rucio accounts.

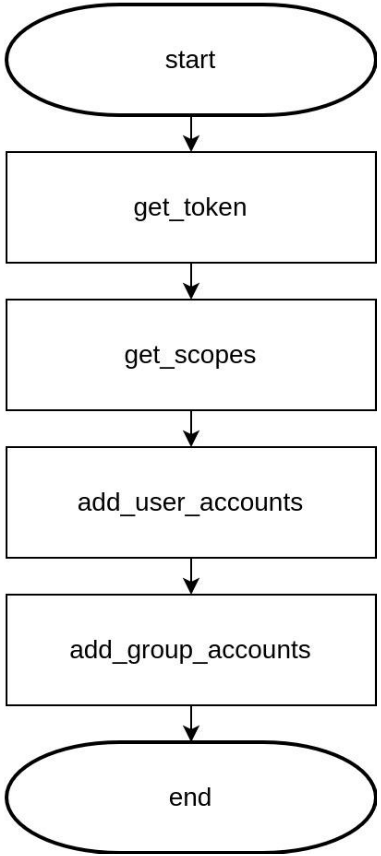
Implemented the addition of the OIDC identities for authentication in Rucio via SPD IAM and addition of the user certificates subject DN for authentication in rucio with usercert and proxy certificates. There is a functionality for adding a subject DN string in legacy format. Also, for each user will be added their standard user scope and a global limit.

Rucio Account Importer [2/3]

The developed utility interacts with SPD IAM using an access, issued to the client who performs actions to import accounts and identification information. This client is registered in SPD IAM with the scope iam.admin:read, scim:read.

The access token contains only these two scopes, which allow the client (in this case, the developed utility) to obtain information about users, their identification information, groups, etc. from the SPD IAM. The lifetime of the token is five minutes. During this time, all operations are performed to obtain information about SPD IAM users and add new information to Rucio. The token grant flow is client_credentials (client_id + client_secret).

Rucio Account Importer [3/3]



start

get_token

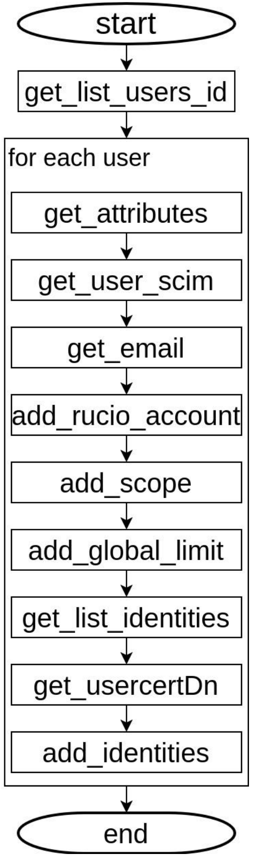
get_scopes

add_user_accounts

add_group_accounts

end

(1) General algorithm



start

get_list_users_id

for each user

get_attributes

get_user_scim

get_email

add_rucio_account

add_scope

add_global_limit

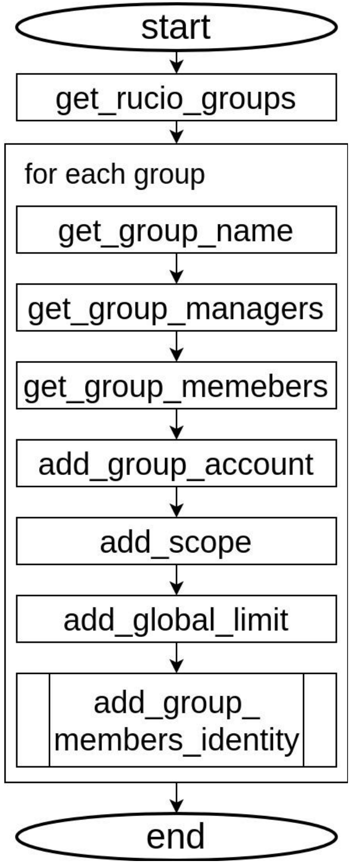
get_list_identities

get_usercertDn

add_identities

end

(2) add_user_accounts algorithm



start

get_rucio_groups

for each group

get_group_name

get_group_managers

get_group_memebers

add_group_account

add_scope

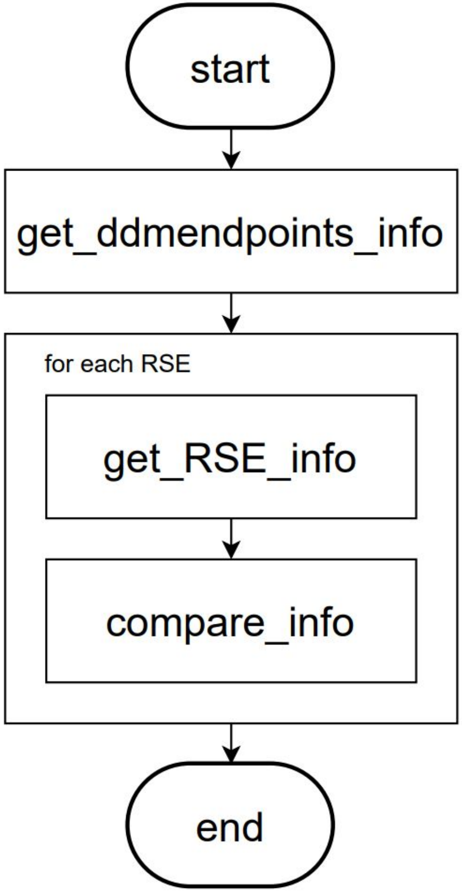
add_global_limit

add_group_
members_identity

end

(3) add_group_accounts algorithm

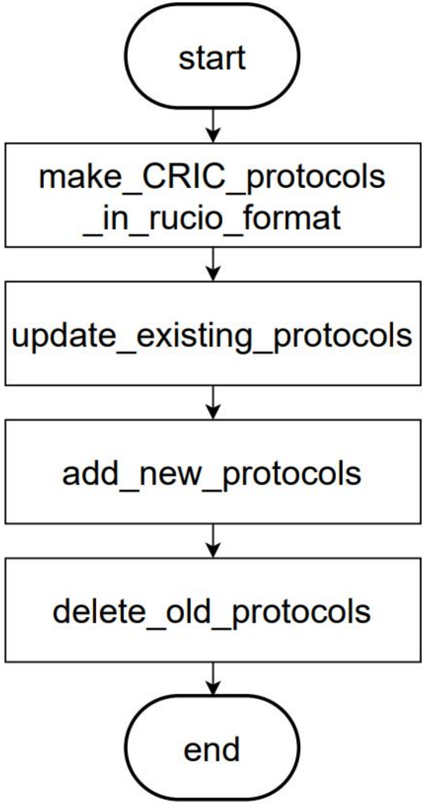
CRIC integration [1/2]



1) Takes information from CRIC about all storage systems registered in it.
2) Requests protocols and attributes of RSE from Rucio.
3) Compares info (changes it if necessary):

- checks attributes;
- checks FTS;
- checks protocols.

CRIC integration [2/2]



start

make_CRIC_protocols_in_rucio_format

update_existing_protocols

add_new_protocols

delete_old_protocols

end

Rucio protocol description

```
{
 "domains": {
   "lan": {
     "delete": 0,
     "read": 0,
     "write": 0
   },
   "wan": {
     "delete": 0,
     "read": 0,
     "third_party_copy_read": 1,
     "third_party_copy_write": 1,
     "write": 0
   }
 },
 "extended_attributes": null,
 "hostname": "somehostname.jinr.ru",
 "impl": "rucio.rse.protocols.webdav.Default",
 "port": 8000,
 "prefix": "/eos/rucio/spd",
 "scheme": "https"
}
```

Hostname, **port** and **scheme** are key attributes of protocol in Rucio.

If any other attribute has been changed -> update_existing_protocol

If any key attribute has been changed -> add_new_protocol and delete_old_protocol

To be continued...