Software management: un servizio di distribuzione del software basato su CernVM-FS

Data management: il modello di datalake per la federazione di storage geograficamente distribuiti

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Outline

Software Management

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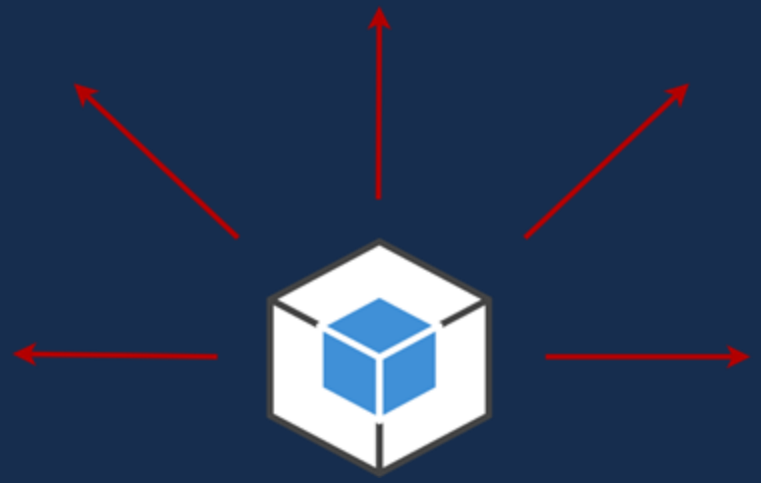
- The Software Management @DataCloud solution
- Workflow overview
- User perspectives

Data Management

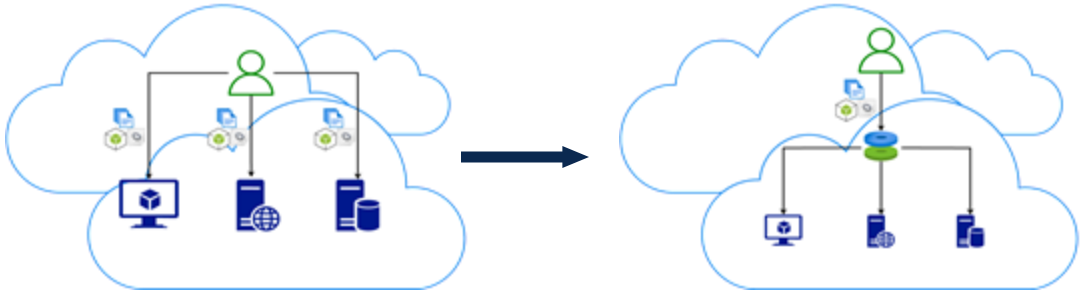
- What is the datalake
- What is RUCIO
- Use case
- Next steps



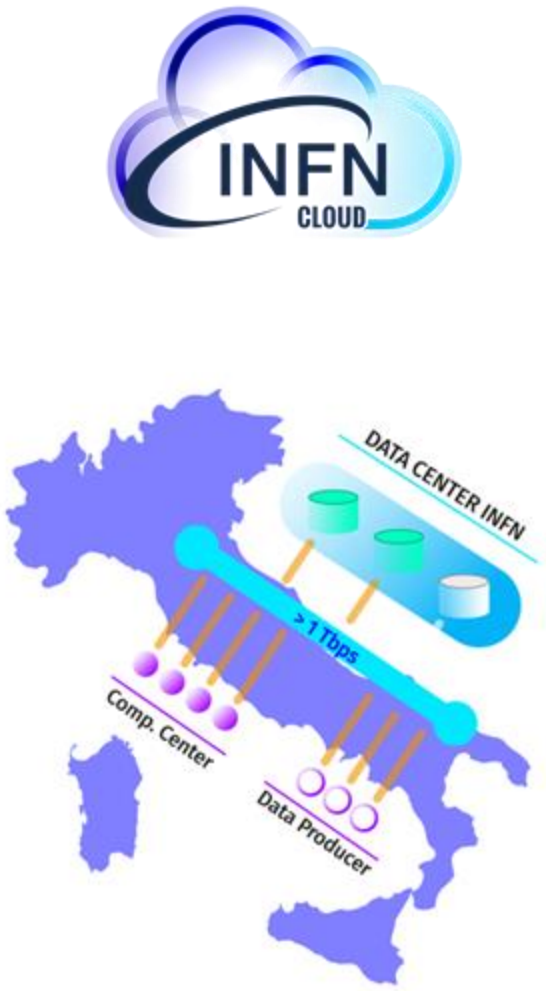
Software Management

Software distribution challenge

- In a **distributed and heterogeneous environment** the **sharing** of software, libraries, configurations and container images in an effective, user-friendly and transparent way can be **challenging**.
- There are already low-level solutions that address this challenge.
- The aim is to further simplify the adoption of a well established technologies such as Cern-VM File System (CVMFS) in a highly **multidisciplinary** environments.



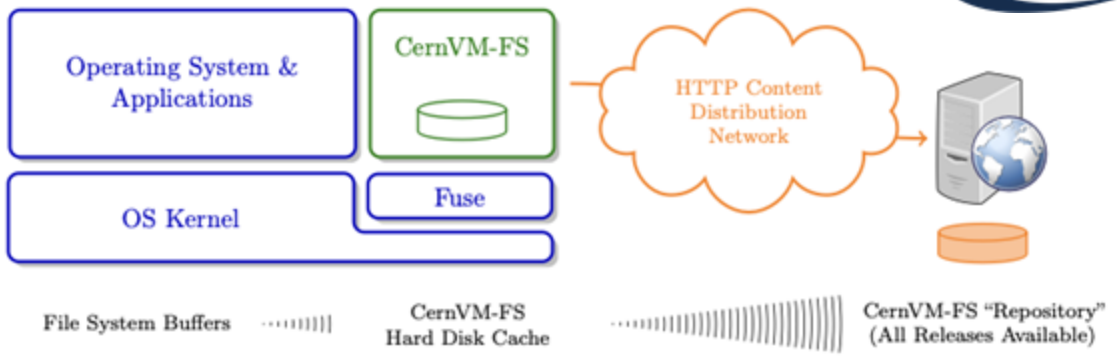
Software Management @DataCloud solution

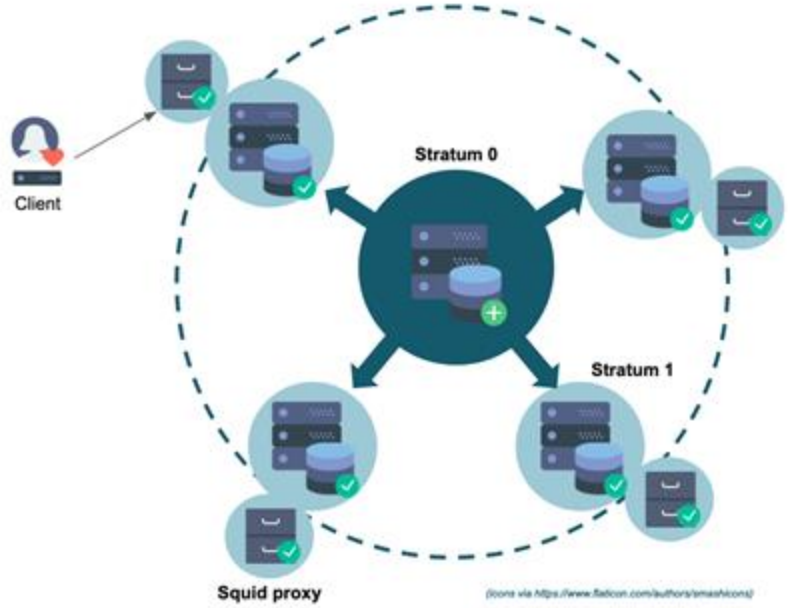


- In order to cope with the challenge in a **Cloud infrastructure**, such as our DataCloud, we implemented a **Software Management service**.
- We build on top of a well established technology known as **CernVM File System** (CVMFS).
- **Abstraction**: what the project adds, is to avoid to know any technical details about CVMFS mechanisms providing **abstractions** in order to let the user accessing the repository in a **simple** and completely **transparent** way.
- **Automation**: in other words we enable the possibility to copy software, libraries and related dependencies, small files, configuration files etc in **S3 cloud storage** and that's it.

CernVM File system

- It's an **open-source**, usable and **customizable** software distribution service.
- It's a network file system implemented as a **POSIX read-only file system**.
- Files and directories are hosted on **standard web servers** and mounted in the universal namespace ***/cvmfs***.
- It uses standard **HTTP transport**, avoiding most of the firewall issues.
- It is a **read-only** files system for those who access it, only the **admin** is able to **modify** its content.





Adopted technologies

CernVM File system

The CernVM File System provides a **scalable**, **reliable** and **low-maintenance software distribution service**. CernVM-FS is implemented as a POSIX read-only file system in user space (a FUSE module). Files and directories are hosted on standard web servers and mounted in the universal namespace /cvmfs.

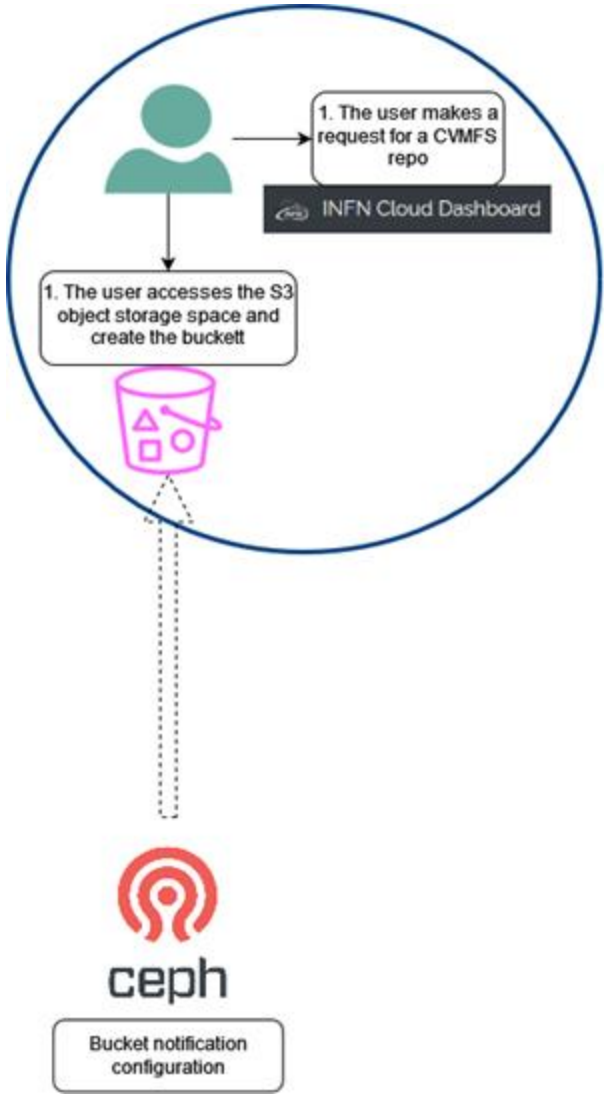
Ceph is an **open-source**, **distributed storage system**.

RabbitMQ provides an **open-source**, **reliable**, **scalable** platform for **message delivery**, through features like message acknowledgements, persistence, routing.

Vault provides organizations with identity-based security to automatically **authenticate** and **authorize** access to **secrets** and other sensitive data.

Software distribution: workflow overview

- The user **requests** a CVMFS repository (personal or group) via the **INFN Cloud dashboard**.
- The request is sent to **RabbitMQ** and is elaborated in order to create the repository.
- Once created, the relative **keys** are published in a **Vault system.**
- The user accesses the **S3 object storage** space and creates a **bucket** (personal or group).
- He **uploads** what he wants to **distribute** in a specific area of the bucket named *cvmfs.*
- The S3 bucket service system sends a message to RabbitMQ so that the system get **notified** and can **synchronize** the content of the correspondent CVMFS repository.
- At this point, the user can access the **CVMFS client** in **read** mode to the **distributed** software.
- Expert users can still use the CVMFS mechanisms to publish their software through CVMFS remote publisher.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INFN Cloud Dashboard
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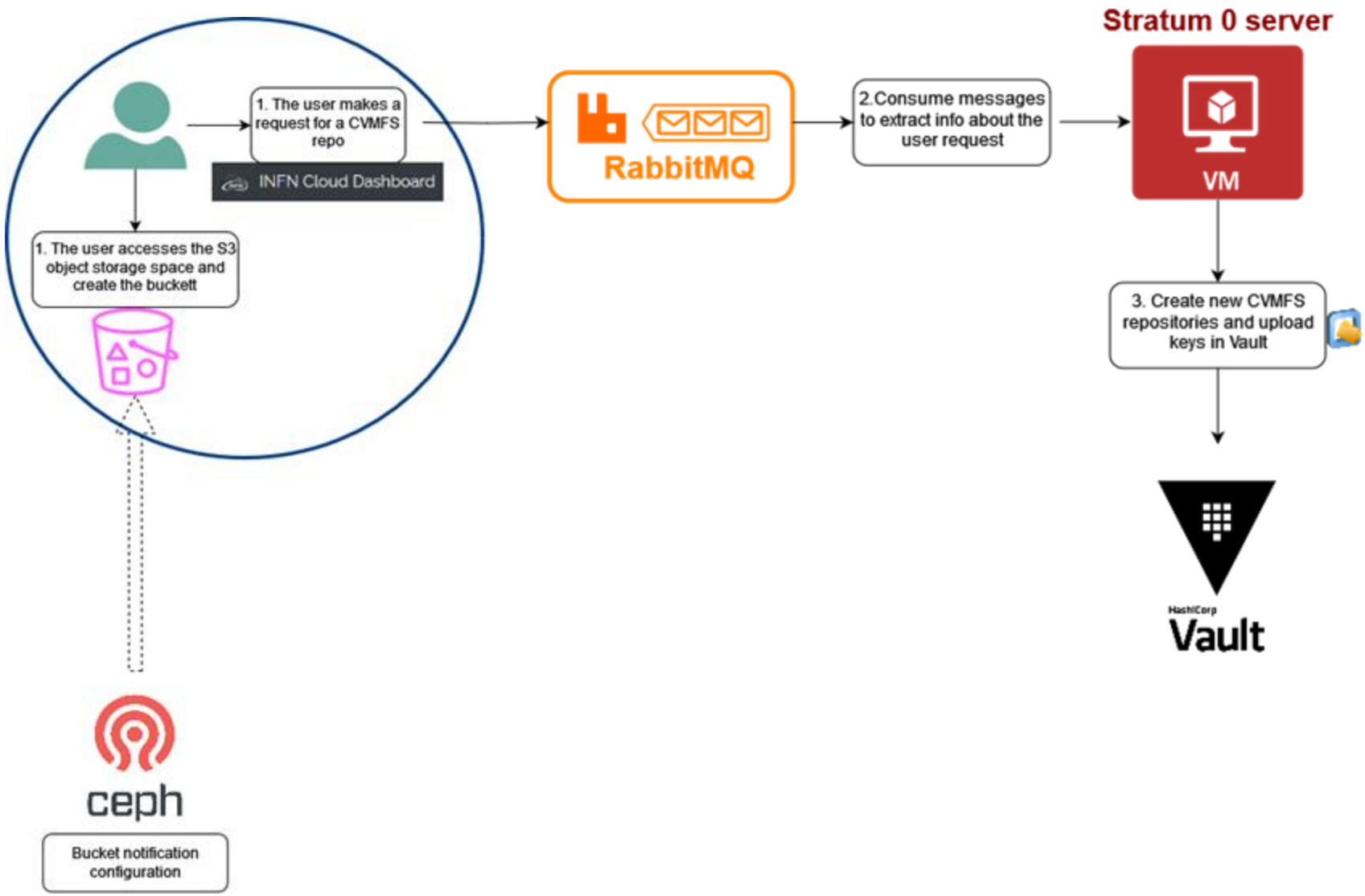
ceph
Bucket notification configuration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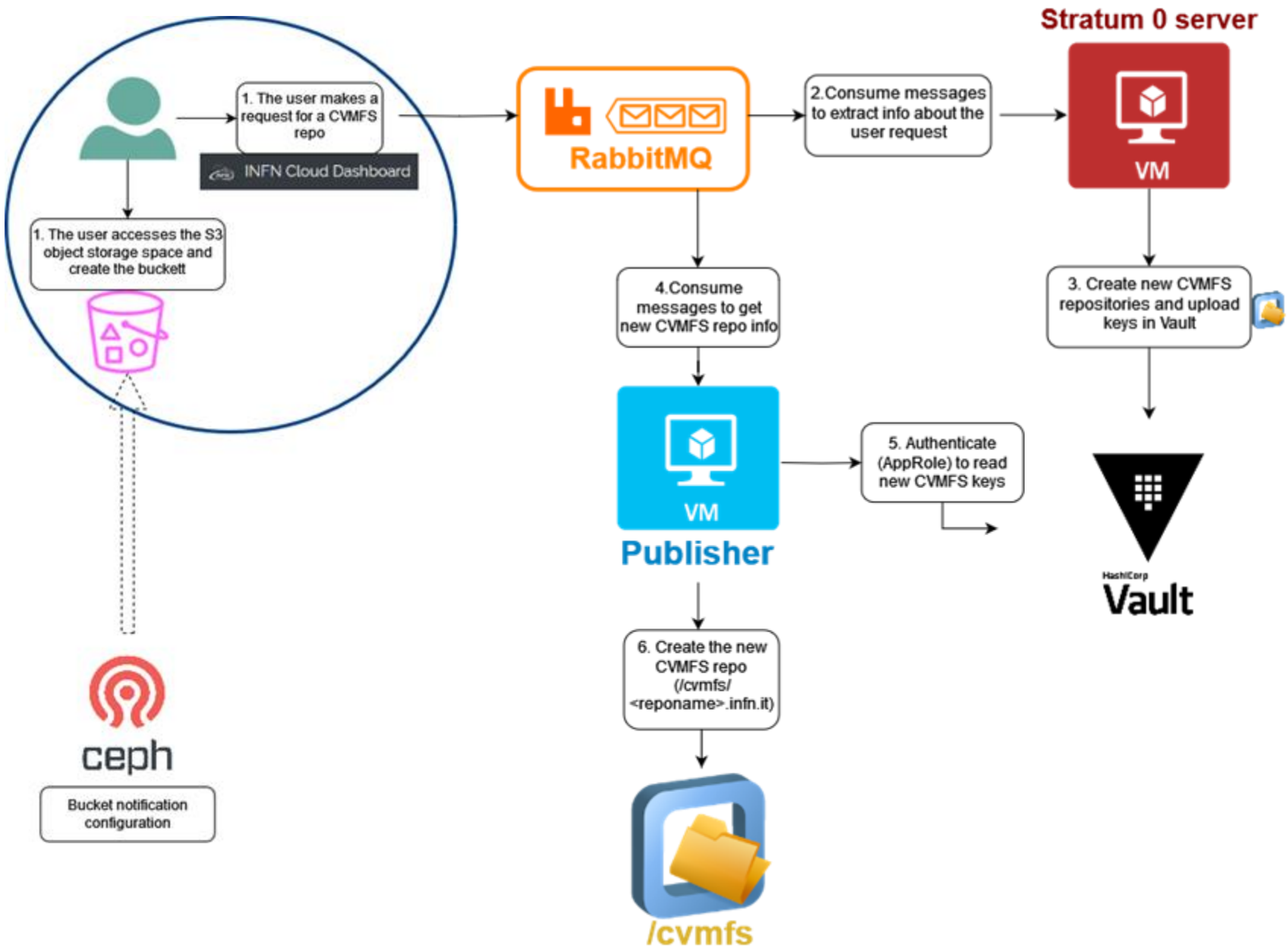
Stratum 0 server
VM
3. Create new CVMFS repositories and upload keys in Vault
HashiCorp
Vault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4.Consume messages to get new CVMFS repo info
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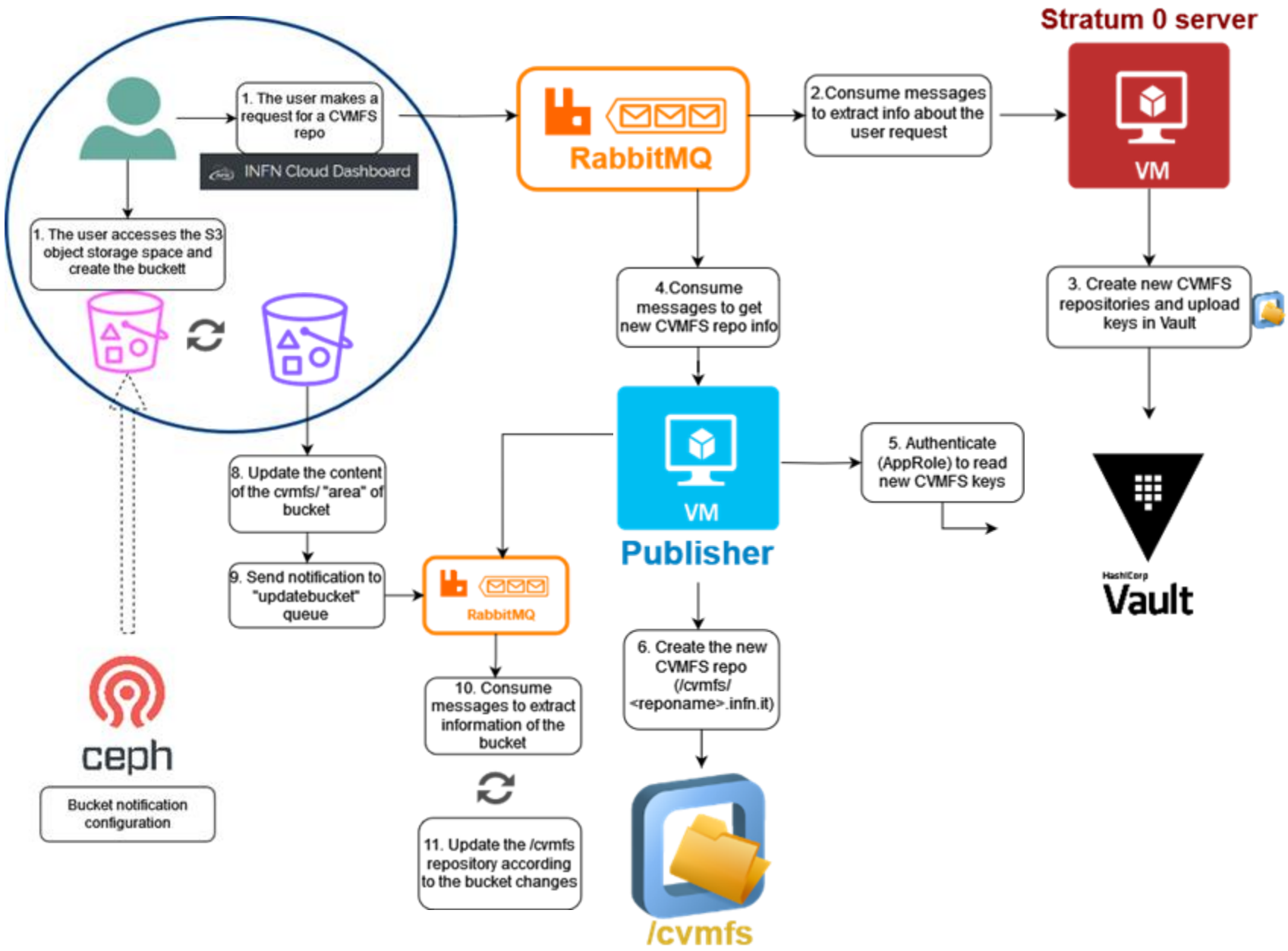
Publisher
5. Authenticate (AppRole) to read new CVMFS keys
6. Create the new CVMFS repo (/cvmfs/<reponame>.infn.it)
/cvmfs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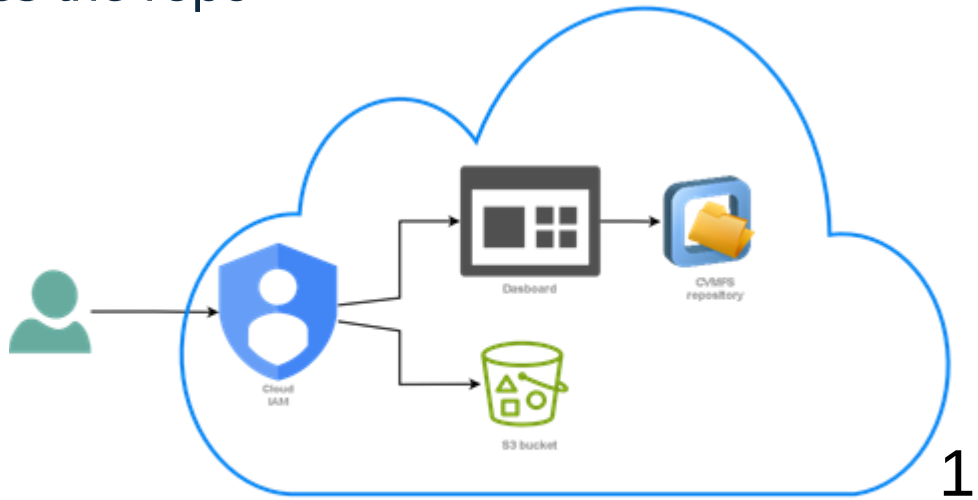
3. Create new CVMFS repositories and upload keys in Vault
8. Update the content of the cvmfs/ "area" of bucket
VM
Publisher
5. Authenticate (AppRole) to read new CVMFS keys
HashiCorp
Vault
9. Send notification to "updatebucket" queue
RabbitMQ
6. Create the new CVMFS repo (/cvmfs/ <reponame>.infn.it)
10. Consume messages to extract information of the bucket
ceph
Bucket notification configuration
11. Update the /cvmfs repository according to the bucket changes
/cvmfs

User perspectives

- The user doesn’t need to know CVMFS, he needs a token and an S3 DataCloud account.
- The user must be **authenticated** through JWT based auth N/Z (based on IAM) to access the Cloud Dashboard.
- The user can **request** a personal CVMFS repository via **dashboard** with one click.
- Access to the **CVMFS repository keys**: they can be easily **downloaded** from the dashboard to configure the **CVMFS client** to access the repo in **read-only** mode.
- The user must have access to the **backbone S3 object storage** to upload Software.



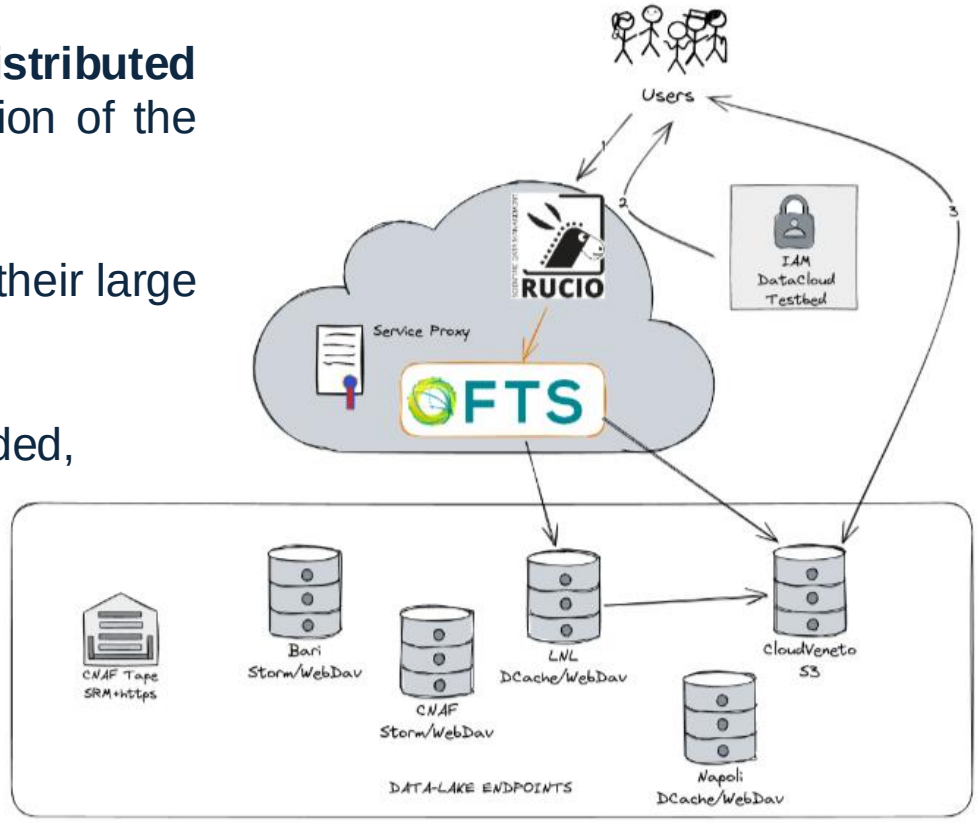
Summary

- Both **abstraction** and **automation** of the underlying CVMFS system are successfully provided by the presented **Software Management service**.
- **Abstraction**: users do not need to know the details of CVMFS, they just **upload** the **software** in their **bucket**.
- **Standard** CVMFS: to expert users is left the possibility to distribute software through a CVMFS **publisher**.
- **Unpacked**: users can use CVMFS to distribute **unpacked container images** via the Harbor registry.
- The Software Managment service is an **open-source** service that can adopted by both single user and group of research.

Data Management

Data Management

- The **federation** of distributed **storage** in the national territory has been discussed extensively in recent years.
- Within INFN, several experiments have been made to federate **distributed** and **heterogeneous** storage and the results is the implementation of the **Datalake model**.
- **Rucio** and **FTS** are the **data management tools** selected due to their large use in some large experiments.
- What we did, was to study how this model can be modified, if needed, in order to be applied in **life-science** use case.
- Having to handle **sensitive data** made us face a significant challenge, since it is important to keep in mind concepts such as **privacy**, **confidentiality** and **information security.**

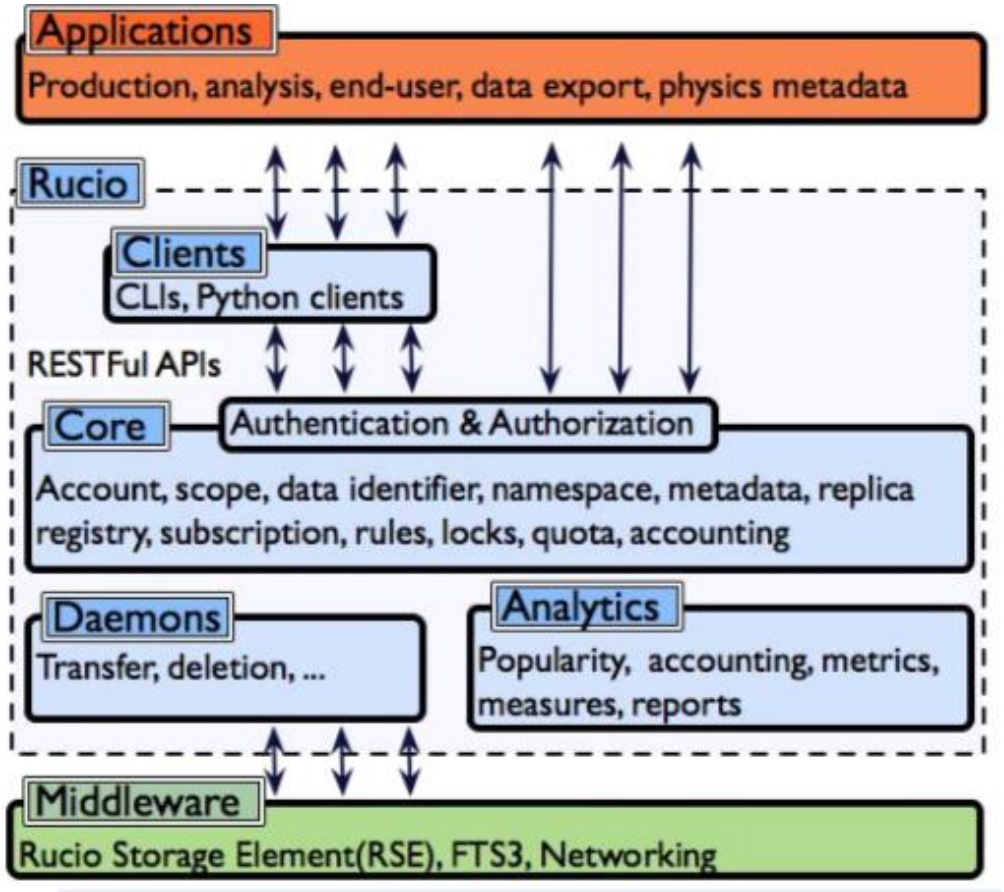


https://agenda.infn.it/event/34683/contributions/197352/attachments/105520/148353/CCR%20-%20Federare%20lo%20storage%20distribuito%20nazionale.pdf

What is Rucio?

- Rucio enables **centralized managment** of large volumes of data **distributed** over **heterogeneous** storage backends.
- Rucio interoperates with heterogeneous storage infrastructures, providing an **interface** that allows users to interact with the storage backends in a **unified way**.
- Rucio enables to **upload**, **download**, and to **declarative manage** groups of files.
- Declarative management is the power of Rucio: users can define **high-level rules** such as "Keep 3 copies on 2 different places".
- If one copy is lost, it will be **automatically re-constructed**.
- Rucio was originally developed to meet the requirements of the high-energy physics experiment ATLAS.
- Now is continuosly extened to support LHC experiments and other diverse scientific communities.

Main Components



Client: consist of components such as the CLI, Python clients, that allow users to interact with Rucio.

Server: manages authentication and provides a common API for interaction with the clients and other external application (the Web UI)

Daemons: are processes in background that take care of the continuous and synchonous workflows.

Persistence layer: Rucio uses PostgreSQL to keep all the logical data and the application states.

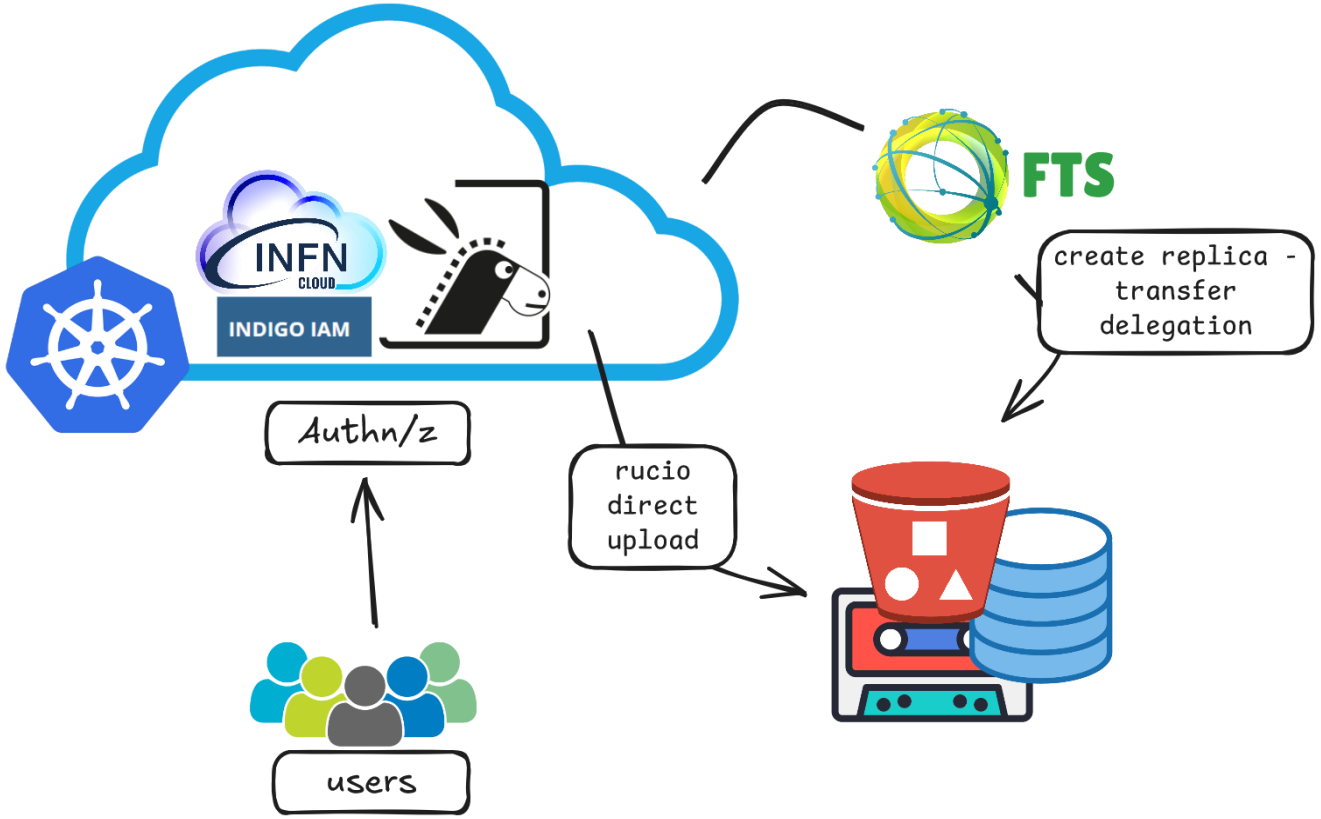
Next to these layers, there are the **storages** resources, and the **transfer tools.**

Rucio deployment

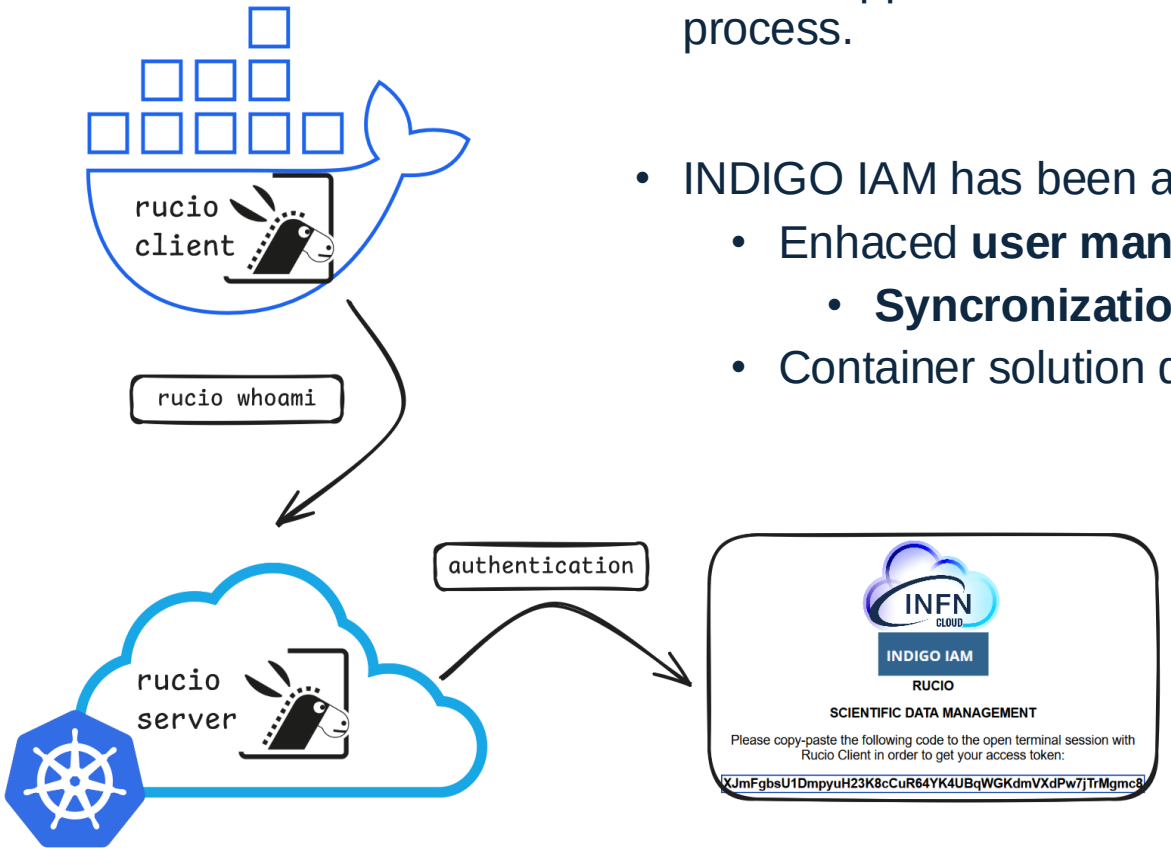
- Cluster kubernetes:
  - Rucio-server
  - Rucio-daemons
  - Indigo-IAM
  - MinIO, object storage

- FTS: open source software for reliable and large-scale data transfers

- Docker: rucio-client for user usage



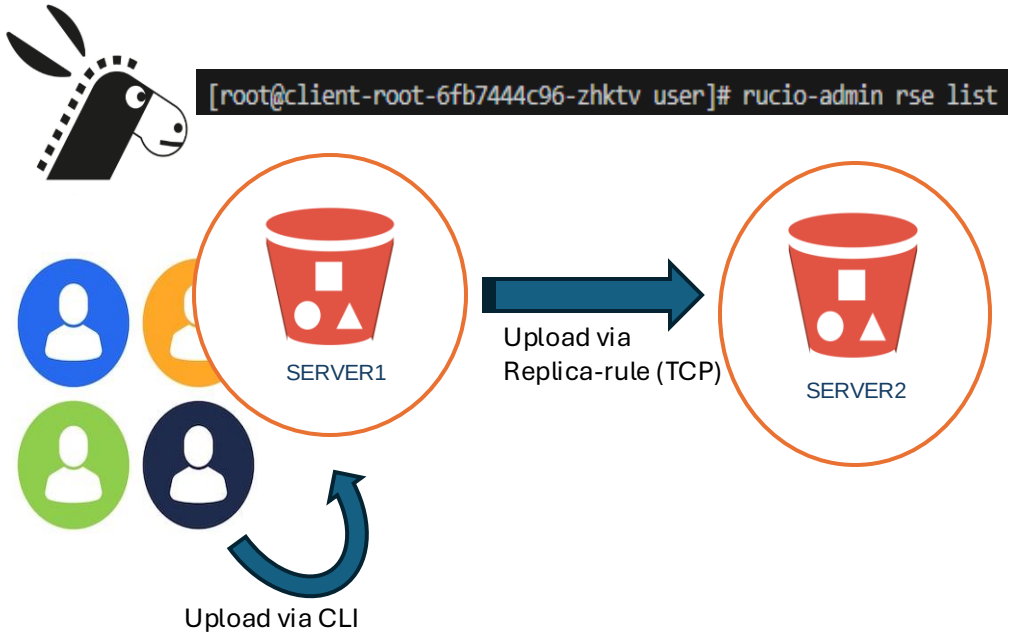
Open ID Connect AuthN/Z



- Rucio support **external identity provider** for the **authentication** process.

- INDIGO IAM has been adopted and configured with Rucio.
  - Enhaced **user management**.
    - **Syncronization** among IAM users and Rucio users.
  - Container solution developed for the the Rucio-Client service.

Use case



- Suppose that the **biomedical community** needs to **transfer** files from one center to another, to **share** information.
- To simulate this scenario, Rucio has been deployed with 2 different MinIO storage providers.
- For each storage provider, different **policies** can be set to share files.

Custom Policy

- Rucio assigns **permissions** to users.
- Permissions are **boolean flags** designating whether an account may perform a certain action (read, write, delete) on a resource (RSE, account, replica, etc.).
- Rucio comes with a generic permission policy including a typical set of **permissions**.

- Policy can be tuned properly to reflect the different community needs.
- e.g. only users belonging to a certain IAM **group** have read/write access.

Auditing

- Auditing is important to check the activity of users in order to **keep track** of their **actions** and to **detect anomalies**
- Deepening rucio logs, we understand it is possible to get information regarding:
  - Timestamp
  - Machine IP of rucio client
  - User access token and rucio user account
  - Tipe of actions + storage endpoint + bucket and DID

- We also find out some **critical issues**:
  - Rucio needs a VOMS-Proxy to delegate transfer to FTS:
    - Apparently they are working on the use of token.
  - FTS web monitoring page was exposing s3 credential:
    - We contact FTS teams and they have now introduced a new variable that hides GFAL credentials.

Summary

- Rucio is an open-source software framework that provides scientific collaborations with the functionality to **organize**, **manage**, and **access large amount of scientific data**.
- Rucio can share data across **distributed locations**, taking advantage of **different technologies** (object storage, block storage, tape, etc).
- The access is controlled by the **authentication** process provided by the external **IdP** and by the **authorization** provided by the costomizable **policies**.
- Rucio has been deployed
  - Locally for testing
  - Within the INFN-Cloud infrastructure
- As a next step there is the integration with other metadata catalog to enrich Rucio functionalities (e.g. Apache Atlas).

Thank you!