



Integrating ESAP with the ESCAPE data lake

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Overview

- The ESCAPE Data lake
 - Overview of Rucio
 - Architecture, glossary of basic terminology
 - Interacting with Rucio
 - Authentication
- Querying data from Rucio from ESAP
- Integrating Rucio storage with Jupyter environment



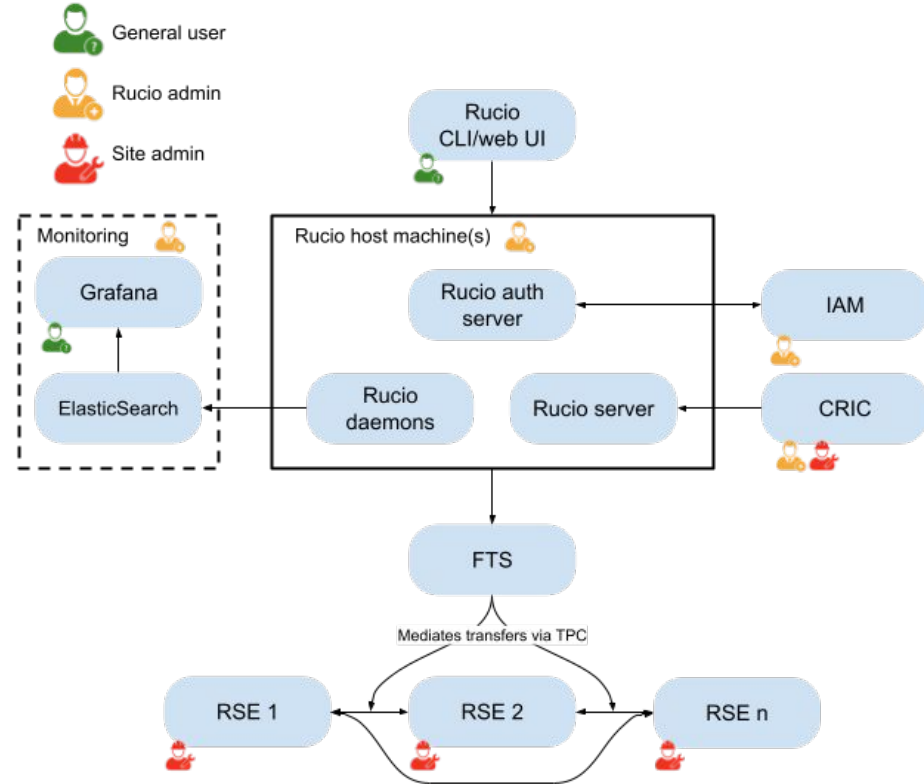
Rucio - the ESCAPE data lake orchestrator

- Rucio is a **large scale scientific distributed data management tool**
 - Built by/for the ATLAS experiment but since has been adopted by CMS, Belle II, ...
- Rucio architecture: **server, daemons, middleware, applications**
 - Server exposes an API, handles authentication etc.
 - Daemons handle asynchronous work to keep the system in the requested state, e.g. transfers, deletions...
- “User” inputs declarative statements that create **rules** constraining how many **copies** of your data you want and **where**
- Storage agnostic: Rucio is not responsible for managing storage - as long as there is a **communication protocol** to talk to it, it can be connected



Rucio architecture

- Rucio server/auth server/daemons run **separately** to data transfer tools
- Commands issued to **FTS** to enact transfers
- RSEs send/receive data between each other directly (**Third Party Copy**)



Rucio terminology

Rucio Storage Element (RSE)	A logical abstraction of a storage system e.g. supported protocols, hostnames, ports, prefixes, ...
Data Identifier (DID)	Unique addressable unit for files, datasets or containers . Follows pattern of < scope >:< name >. DIDs are unique within the full namespace.
Scope	A partitioning of the full namespace.
Name	Self explanatory. Names are unique within a scope .
Dataset	A collection of dids.
Container	A collection of datasets or, recursively, containers .
Rule	The medium by which the user affects the system state and by which the state is constantly evaluated for compliance, e.g. " <i>make two copies of data, one on disk and one on tape</i> "
Replica	The physical result of a <u>replication rule</u> , i.e. bytes on storage



Interacting with Rucio

- **REST API**

- Directly call Rucio server via HTTP/REST
- (https://rucio.cern.ch/documentation/html/rest_api_doc.html)
- e.g. `$ curl --request GET --url http://<SERVER_URL>/rules/{RULE_ID} --header 'X-Rucio-Auth-Token: <TOKEN>'`

- **Rucio CLI client**

- Containers available (<https://hub.docker.com/r/rucio/rucio-clients>)
- e.g. `$ rucio rule-info <RULE_ID>`

- **Rucio Python clients**

- PIP installable (<https://pypi.org/project/rucio-clients/>)
- e.g. `>>> RuleClient.get_replication_rule(<RULE_ID>)`



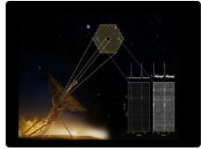
Data Lake Authentication

- Three modes of auth:
 - X.509 (legacy)
 - User/pass (deprecated)
 - **OIDC token**
 - Built on OAuth2.0
- Rucio server authenticates with **Indigo IAM** service, gets token
- Token is **exchanged** for FTS/storage site operations



Demo: Querying Rucio data lake from ESAP

WSRT-Apertif



Apertif Surveys

Data from the Apertif surveys include imaging and time-domain data. The time-domain products consist of high-time resolution filterbank data in the PSRFITS standard. The imaging data products include the raw observations in the measurement set (MS) standard format. In addition, processed data products are available, including calibration tables, calibrated visibilities, multi-frequency synthesis continuum images, polarization images and cubes, and uncleaned neutral hydrogen (HI) line and

ASTRON VO



ASTRON Virtual Observatory

The Virtual Observatory defines a set of standards that can be used to download astronomical data. The ASTRON VO contains several image survey, which are images in the FITS format. Since the VO is currently under development, more data types will be available in the future.

[Visit ASTRON VO Archives](#)

Zooniverse



Zooniverse Classification Database

The Zooniverse is the world's largest and most popular platform for people-powered research. This research is made possible by volunteers — more than a million people around the world who come together to assist professional researchers. Our goal is to enable research that would not be possible, or practical, otherwise. Zooniverse research results in new discoveries, datasets useful to the wider research community, and many publications.

Virtual Observatory (VO)



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[Visit Virtual Observatory \(VO\) Archives](#)

RUCIO



Rucio

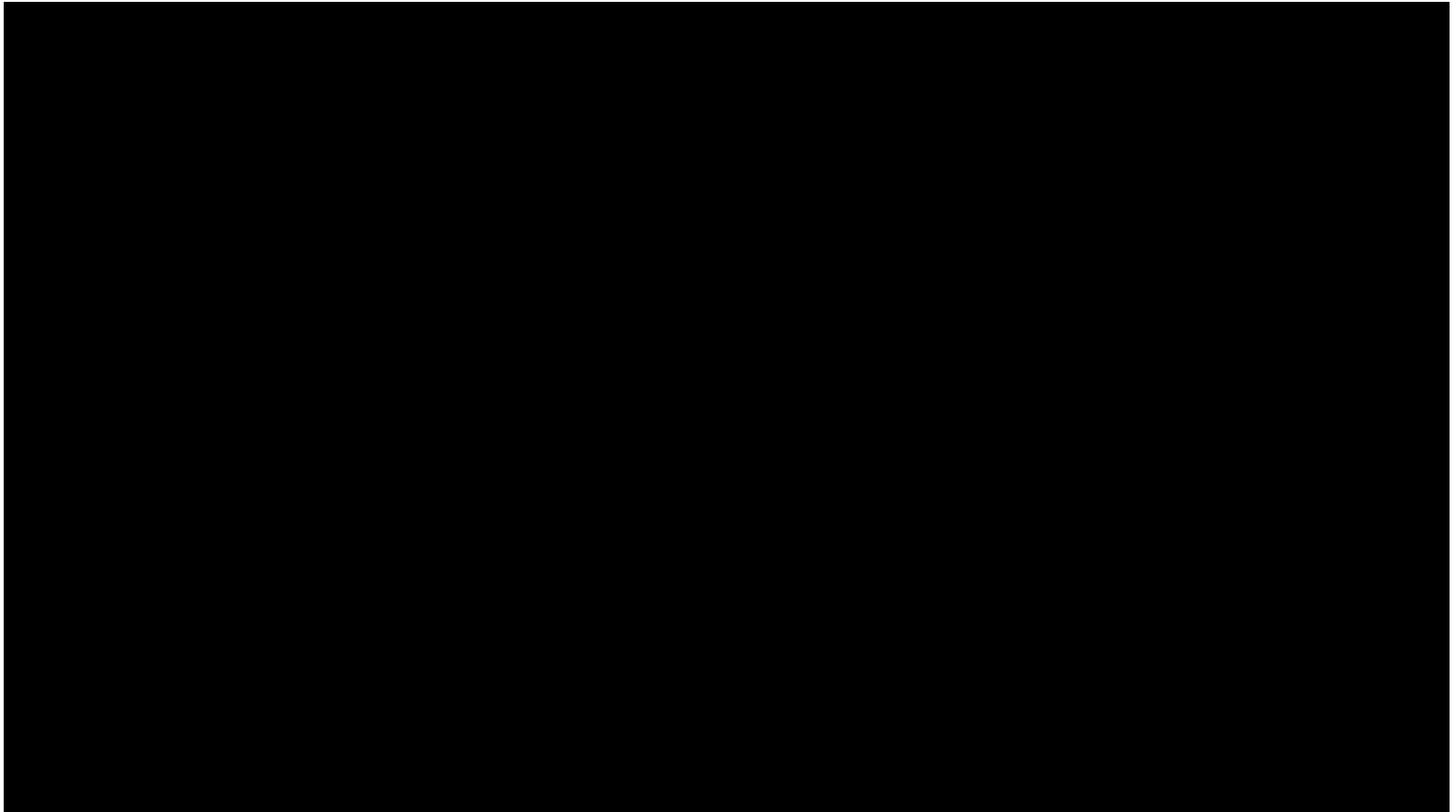
Built on more than a decade of experience, Rucio serves the data needs of modern scientific experiments. Large amounts of data, countless numbers of files, heterogeneous storage systems, globally distributed data centres, monitoring and analytics. All coming together in modular solution to fit your needs.

[Visit RUCIO Archives](#)

Credit: Hugh Dickinson, Yan Grange, Nico Vermaas, Zheng Meyer, Klaas Kliffen



Demo: Querying Rucio data lake from ESAP



JupyterHub / BinderHub

- JupyterHub - web application which can **dynamically spawn** Jupyter Notebook server apps
- These allow a user to **write** code (usually Julia/Python/R), **run** it, and **view/share** the output
- A number of instances have been deployed at institutes - **provide IDA resources to ESAP**
- Binder is a tool which can **generate** Jupyter Notebook environments from Binder-ready **code repos**
- BinderHub is the combination of Binder running **with** a JupyterHub



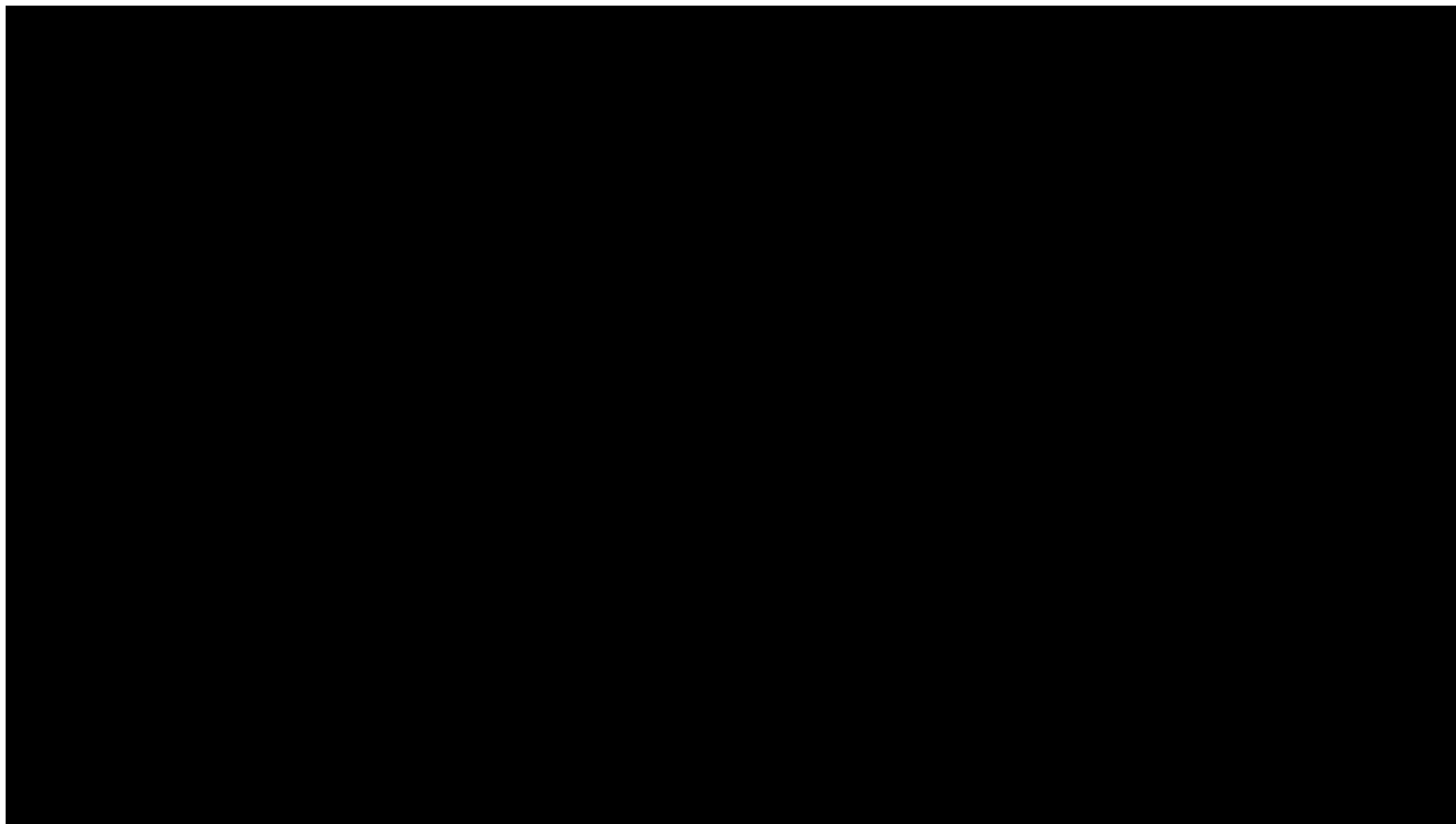
Bringing compute to the data

- JupyterHub is a good way to securely provision **compute** to users
- Integrating with storage requires some configuration
- **Persistent storage** can be configured which allows for per-user **scratch** spaces and **shared volumes**
- Configuring with Rucio has been demonstrated initially by **CERN***, through the **Rucio-JupyterLab extension** - this is colloquially known as the '**Data Lake as a Service**' (DLaaS)

*Credit **Muhammad Aditya Hilmy, Rizart Dona, Riccardo Di Maria**



Data lake as a Service



DLaaS Requirements

- RSE colocated with JupyterHub
- Jupyter Notebook environments have read-access to RSE volume
- Prerequisites:
 - JupyterHub
 - Colocated RSE
 - Rucio server } OIDC token authentication
- Custom JupyterHub and Notebook server images
- ConfigMaps to prep Rucio client/setup token refresh
- Detailed setup/config guide available on request

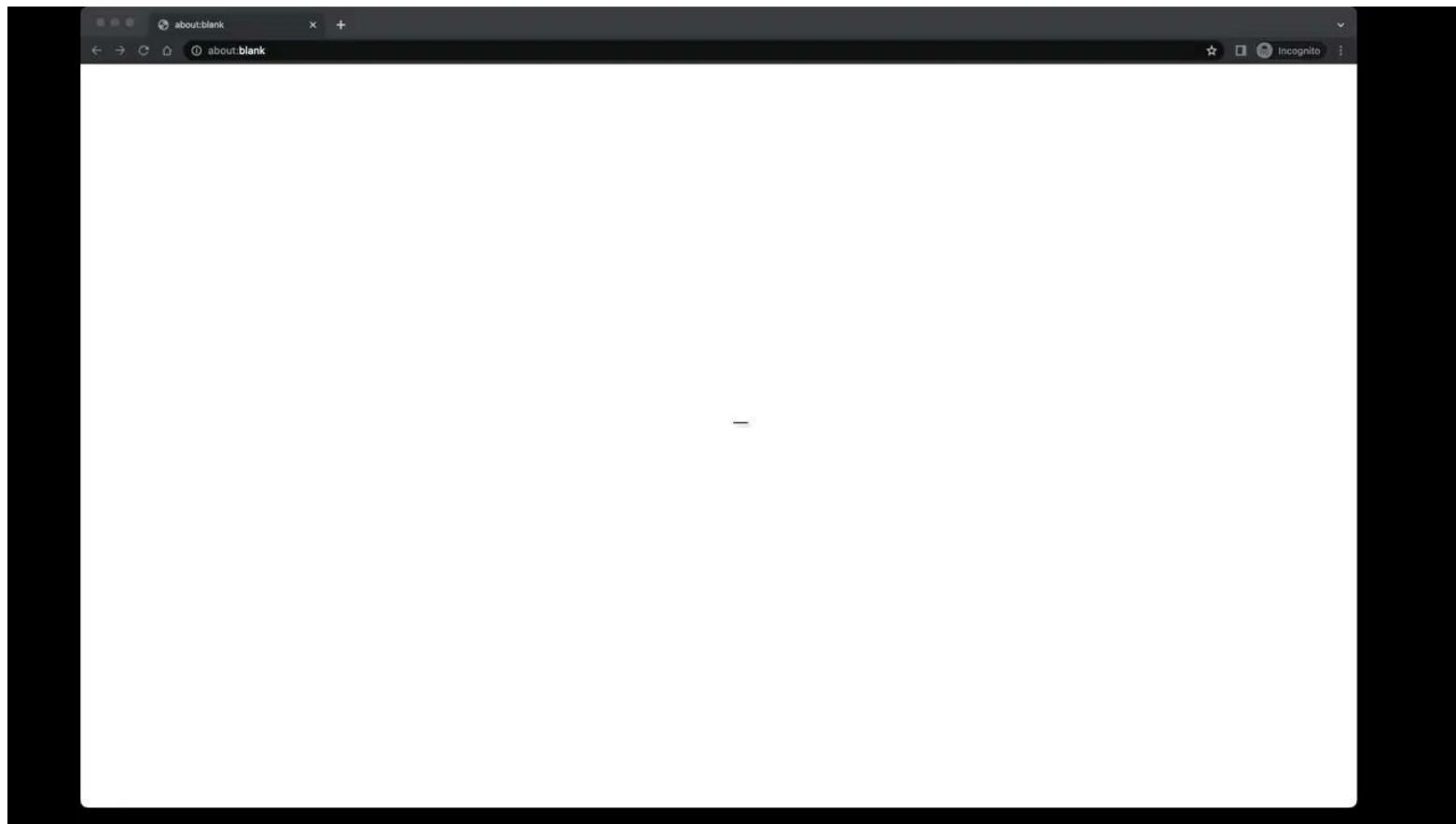


DLaaS-ESAP Shopping Basket integration

- ESAP data from queries can be put in a “shopping basket”
 - Using a python client, the references to the data (e.g. URLs to images, or Rucio DIDs) can be obtained
- Shopping basket works with “connectors”
 - Minimal connector defines how to select data from a specific source
 - Also connectors can contain custom data access functionality



Demo: DLaaS-ESAP Shopping Basket integration



Summary and Next Steps

- Rucio integrated with ESAP for data discovery
- Data lake as a Service brings computation to data managed by Rucio

Future

- Improved query mechanism
 - Metadata over DIDs?
 - Improved IVOA metadata integration in development
- More streamlined authentication mechanism
- Tighter integration with interactive analysis



Questions?

