ATLAS
EXPERIMENT

The data management system Rucio
Evolution for LHC Run-3 and beyond ATLAS

Martin Barisits, Thomas Beermann, Joaquin Bogado, Vincent Garonne,
Tomas Javurek, Mario Lassnig, Cedric Serfon, Tobias Wegner
on behalf of the ATLAS collaboration

martin.barisits@cern.ch

Rucio

- Rucio provides a complete and generic scientific data management service
  - Data can be scientific observations, measurements, objects, events, images saved in files
  - Facilities can be distributed at multiple locations belonging to different administrative domains
  - Designed with more than 10 years of operational experience in large-scale data management!

- Rucio manages multi-location data in a heterogeneous distributed environment
  - Creation, location, transfer, and deletion of replicas of data
  - Orchestration according to both low-level and high-level driven data management policies (usage policies, access control, and data lifetime)
  - Interfaces with workflow management systems
  - Supports a rich set of advanced features, use cases, and requirements

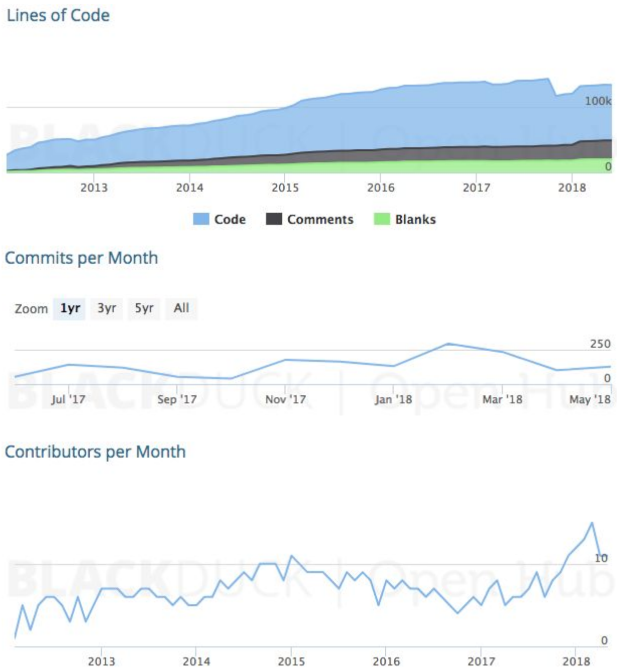
Rucio

- Objective was to minimise the amount of human intervention necessary
- Large-scale and repetitive operational tasks can be automated
  - Bulk migrating/deleting/rebalancing data across facilities at multiple institutions
  - Declarative/policy-based
  - Popularity driven replication and deletion
  - Management of disk spaces and data lifetime
  - Identification of lost data and automatic consistency recovery
- Administrators at the sites are not operating any local Rucio service
  - Sites only operate their storage
  - Users have transparent access to all data in a federated way
- Easy to deploy

Open source project

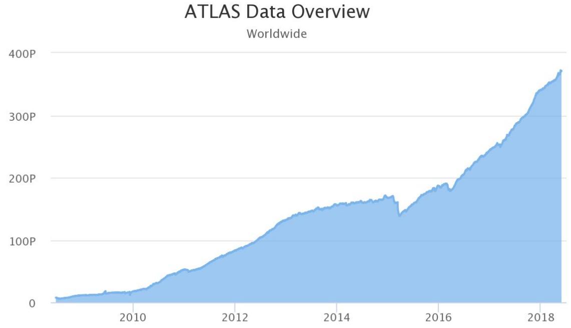
- Established as an open-source project
  - ○ 30 contributors, 19 ATLAS, 11 non-ATLAS
  - ○ 131k lines of code, 120 commits per month
  - ○ Supports various database backends
- 1st Rucio Community Workshop
  - ○ 90 participants
  - ○ 16 communities
- Focus on established open source tools
  - ○ 400+ unit tests via Travis, Containers, readthedocs

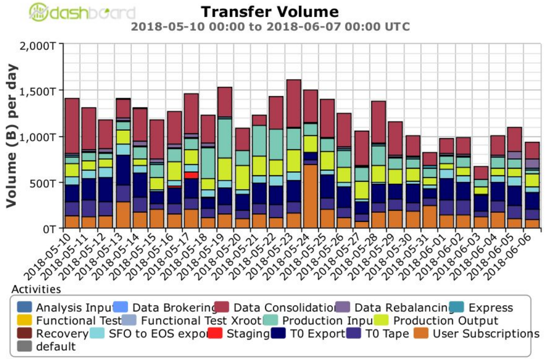
Contributions are always welcome!



Community

- ATLAS
  - Approaching 400PB
  - 10M containers, 20M datasets, 1B files
  - 5K accounts, 10K identities
  - 1-2PB transfers / day, 3PB deletions / day
  - 130 sites, 600 storage endpoints
- ASGC: AMS + others
  - Several million files, 10 sites
- Xenon1T
  - 5.6 PB, 100k files, 6 sites
- Under evaluation by many communities
  - CMS, SKA, OSG (LIGO, IceCube), EISCAT_3D, FNAL (DUNE), XDC





Generic metadata support

- Primarily needed by non-ATLAS experiments using Rucio
- Rucio supports different types of metadata
  - System (size, checksums, status, creation time, …)
  - Physics (number of events, lumi block, …)
  - Production (task id, job id, …)
- Generic metadata support via arbitrary JSON encoded cells
  - Supported by PostgreSQL, MySQL, and Oracle
    - SQLAlchemy ready for PostgreSQL and MySQL
  - Currently hosting Google Summer of Code (GSoC) student to implement a prototype
  - Objective
    - Fully flexible metadata
    - Multi-billion cell search performance
    - Combined lookup queries

Workload aware service components

- Full workload aware system components
  - Based on the backlog and priority, service components increase their instances and split the workload accordingly
  - Provide a constant level of service performance
  - React to priority tasks/campaigns with the needed amount of resources
- Auto-scaling needed for all service components
  - Already the case for some (rules, messages, subscriptions) but needed for others (deletion, transfers)
- Load analyzing orchestrator
  - Decides to start/kill service instances based on workload and priority
  - Possibly a Kubernetes Controller

Deployment and packaging

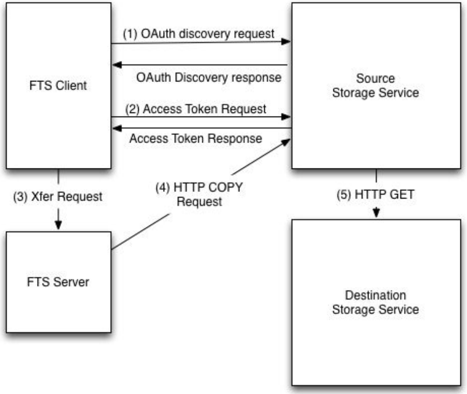
- Python versions
  - Clients: 2.6, 2.7, 3.5 2.6 will be dropped end of 2018
  - Server: 2.7 3.5 coming soon
  - 3.6 compatibility planned
- Packaging
  - PIP: Will keep providing general pip package as well as one for clients and webui
  - Containers: Will keep providing different docker containers on dockerhub
- Kubernetes
  - **Objective**: Turnkey deployment of Rucio
  - Currently testing a Rucio kubernetes cluster deployment for server-only (no daemons)
  - Plan is to offer a full-stack service deployment, including all daemons and load-balancing provided by Kubernetes

Quality of service

- Representation of QoS attributes in Rucio
  - RSE Attributes
  - Latency, Throughput, Bring-Online delay, …
- Cost of Service
  - Also RSE Attributes
  - Storage, ingress, egress (Can be combined with rule lifetime and size)
- System needs to be flexible to generically support storage classes
  - Together with storage and network providers
- **Objective:** Rucio replication rule can effectively select a storage destination based on QoS and CoS claims
  - ⟶ Enables Rucio to not only optimize on #transfers and storage volume but also on cost

Authentication/Authorisation

- Clear wish for more authentication/authorisation methods
- Bearer tokens
    - Delegate authorisation decision back to experiment
    - Refresh/expire tokens on demand
- OAuth style workflows
    - OpenID
- SciTokens, Macaroons, Cloud Signatures
    - Support coming in various components
- For authentication, federated identity support with EduGAIN would be useful



Event-level Data Management

- Representation of a physics event and association with a file
- Research ongoing but different possibilities:
  - Extending the definition of a data identifier (file, dataset, container) to event
    - All rucio commands can be executed with an event identifier
      - rucio download <event>
    - Metadata (which?) on events
  - Fetching and syncing event information from external services

Summary

- Rucio well established as an open source community project
  - Focus on widely used open source tools and workflows
- Used beyond ATLAS by Xenon1T and AMS (ASGC)
- Under evaluation by many other experiments
- Strong development plan, focusing on HL-LHC as well as beyond-ATLAS
- Participation is very welcome!

More information

Website	http://rucio.cern.ch
Documentation	https://rucio.readthedocs.io
Repository	https://github.com/rucio/
Continuous Integration	https://travis-ci.org/rucio/
Images	https://hub.docker.com/r/rucio/
Online support	https://rucio.slack.com/messages/#support/
Developer contact	rucio-dev@cern.ch