Prototyping a Bulk Data Management System for CTAO with Rucio

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ABSTRACT

The Bulk Data Management System (BDMS) is a key subsystem of the Cherenkov Telescope Array Observatory (CTAO)'s Data Processing and Preservation System (DPPS) designed for long-term preservation. BDMS leverages Rucio — an open-source data management system developed at CERN. BDMS manages the ingestion of data products on-site, replication of data between CTAO Data centers, ensure their long-term preservation, and provide an interface to ingest, query, and retrieve.

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CONTEXT

BDMS manages the temporary and long-term storage of all data products from raw data (data level 0 – DL0) up to Science-ready (DL3) and for Category B (next-day) and reprocessed data.

The DPPS pipeline sub-systems provide software and workflows that execute on another DPPS sub-system, the Workload Management System (WMS). The incoming DL0 raw data coming from Array Control and Data Acquisition System (ACADA) is produced on-site while the off-site products will be higher-level data produced by WMS, and storage of both these data is managed by BDMS.

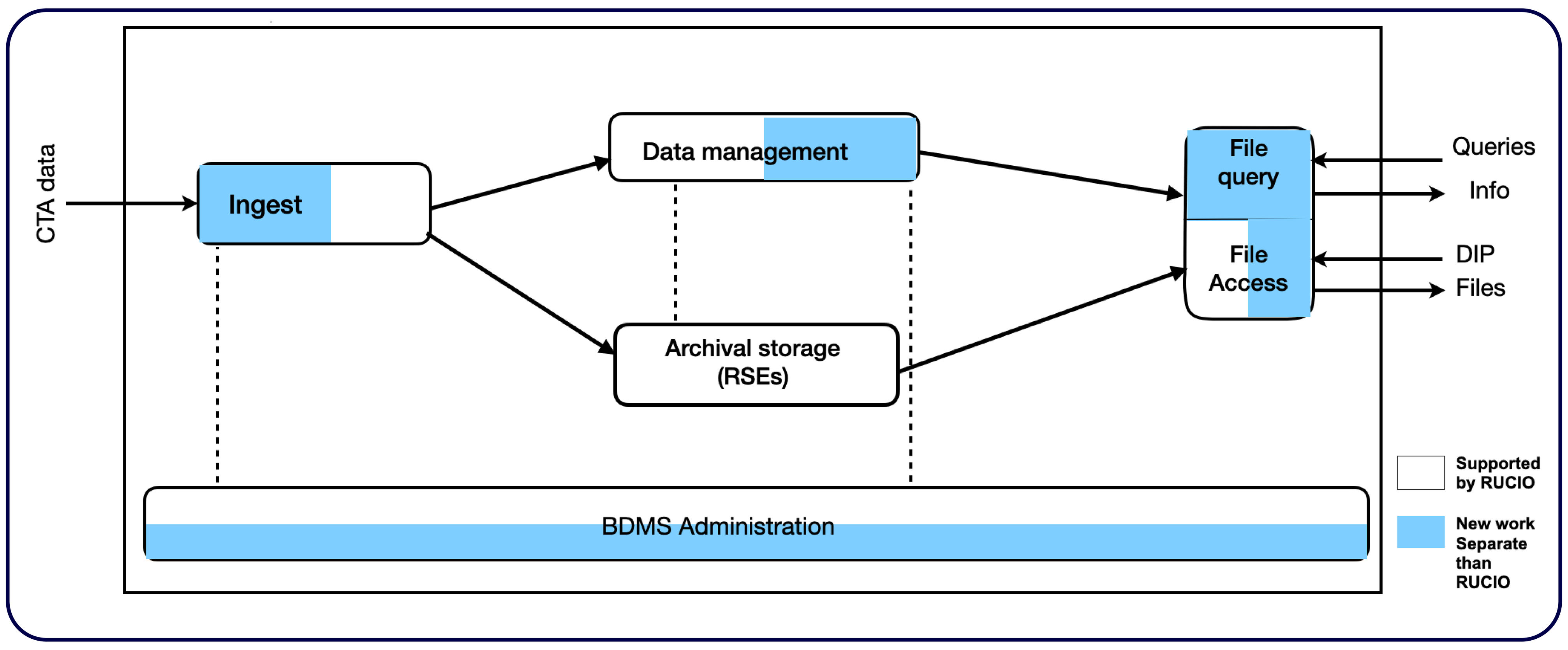

Fig. 2: BDMS architecture high-level logical flow

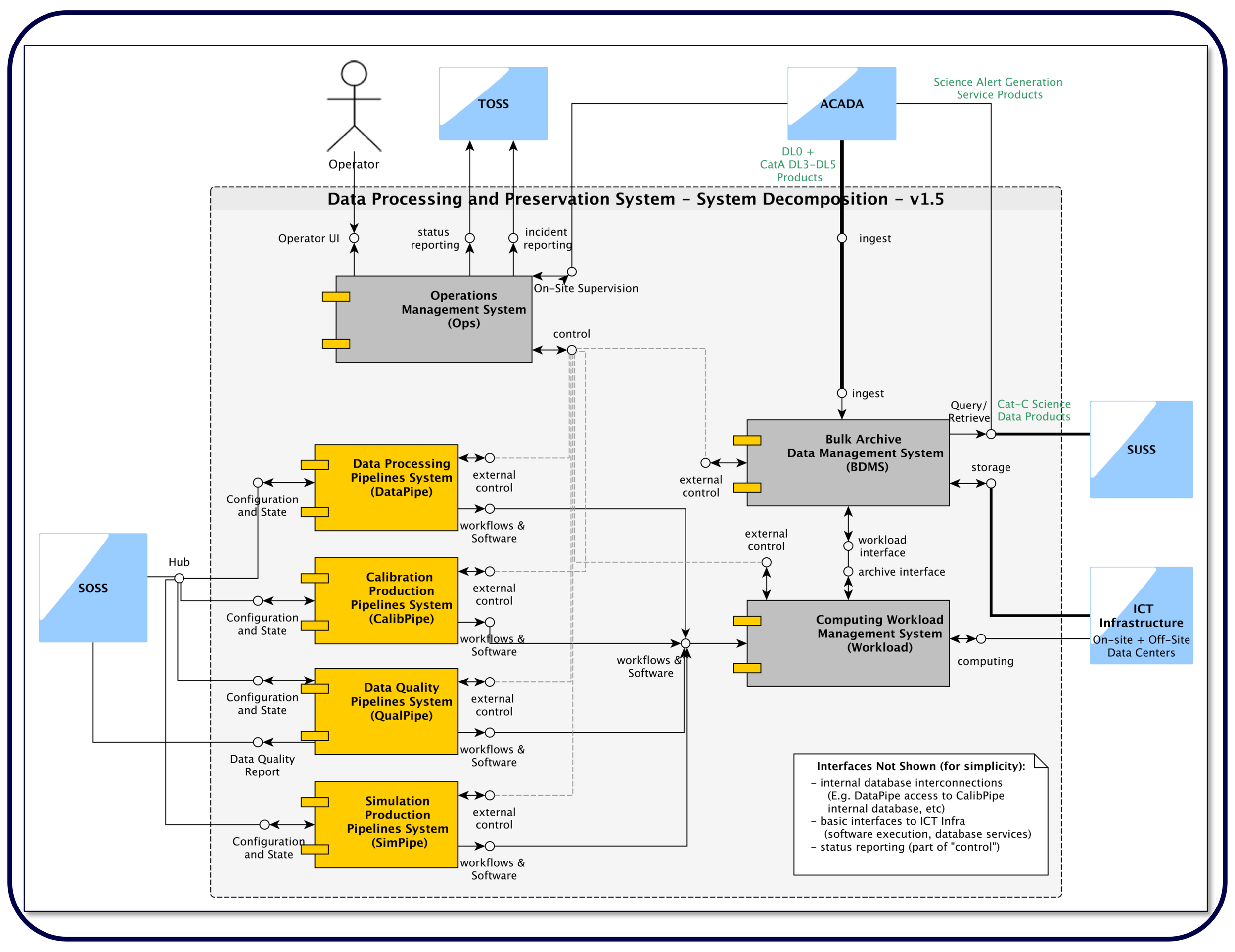

Fig. 1: BDMS Functional Diagram
(Taken from DPPS concept document draft version 2.5)

ARCHITECTURE

BDMS follows the Open Archival Information Systems (OAIS) design principle and composed of multiple functional units. **Ingest** checks the integrity of the data before extracting metadata following up with actual ingestion and replication for the bulk archive. Data management involves tracking preservation and monitoring.

ACKNOWLEDGEMENTS

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INGEST

The **Ingest** component depends on Rucio to manage the ingestion of products at on-site and off-site locations. In case of ACADA DL0 raw data coming from telescopes on-site and transferred to DPPS, **Ingest** handles both the ingestion on-site and replication to at least two off-site data centers. An ingestion queue daemon part of **Ingest** orchestrates automated and parallel ingestion and replication of incoming data using subprocess design.

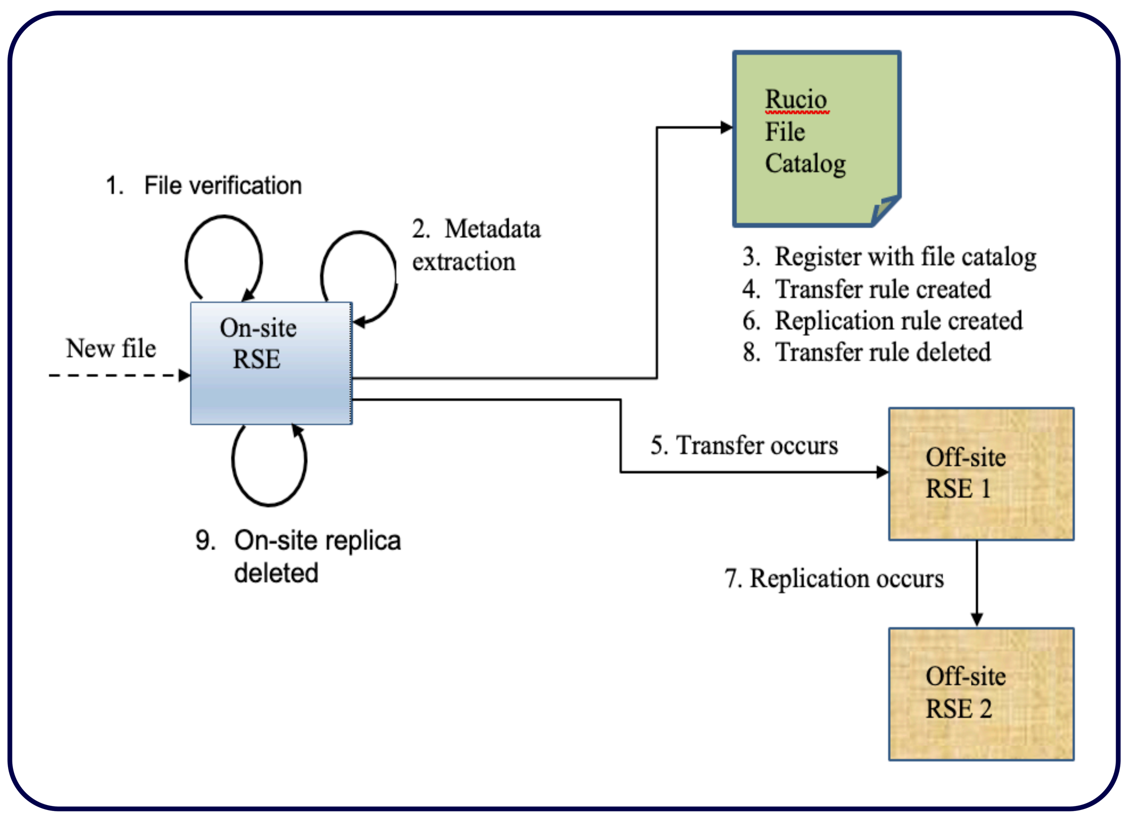

Fig. 3: Control flow of Ingest and Replication of DL0 data products produced on-site from ACADA

PROTOTYPING CONTRIBUTIONS

- **Helm chart based containerized deployment:**
  kind cluster for local development and CI pipelines; single BDMS chart with sub-charts for all dependencies.
- **BDMS code development and testing with continuous integration (CI) pipelines:**
  Implemented use-cases related to (i) Ingestion on-site with metadata, (ii) Replication to two off-site storage elements for data preservation, (iii) Ingestion Queue daemon to support parallel ingestion.

CURRENT STATUS AND NEXT STEPS

The BDMS code development started with testing core Rucio functionality and further progress made with implementation of ingestion, replication, and ingestion queue daemon use-cases, respectively.

The next steps include ACADA DL0 ingestion of files on-site at La Palma and replication to Port d'Informació Científica (PIC, Spain) and other data centers, integration of Indigo IAM authentication for users; and, WMS data ingestion for short-term storage.