Online processing systems for BM@N Run 9

Ilya Romanov, Konstantin Gertsenberger

BM@N SOFTWARE TEAM

Introduction

Based on Workflow Orchestration Tool

This tool is used to process raw files stored in the Ceph distributed storage system on the DDC cluster during the experiment. It **replicates** raw files to the NCX and CICC clusters, **archives** them on magnetic tape data storage, and initiates the **conversion to ROOT** format and **reconstruction processes** using DIRAC.

Based on COnfiguration Online Platform (COOP)

It is used to process raw data published via a ZeroMQ socket during the experiment to **control data quality**.

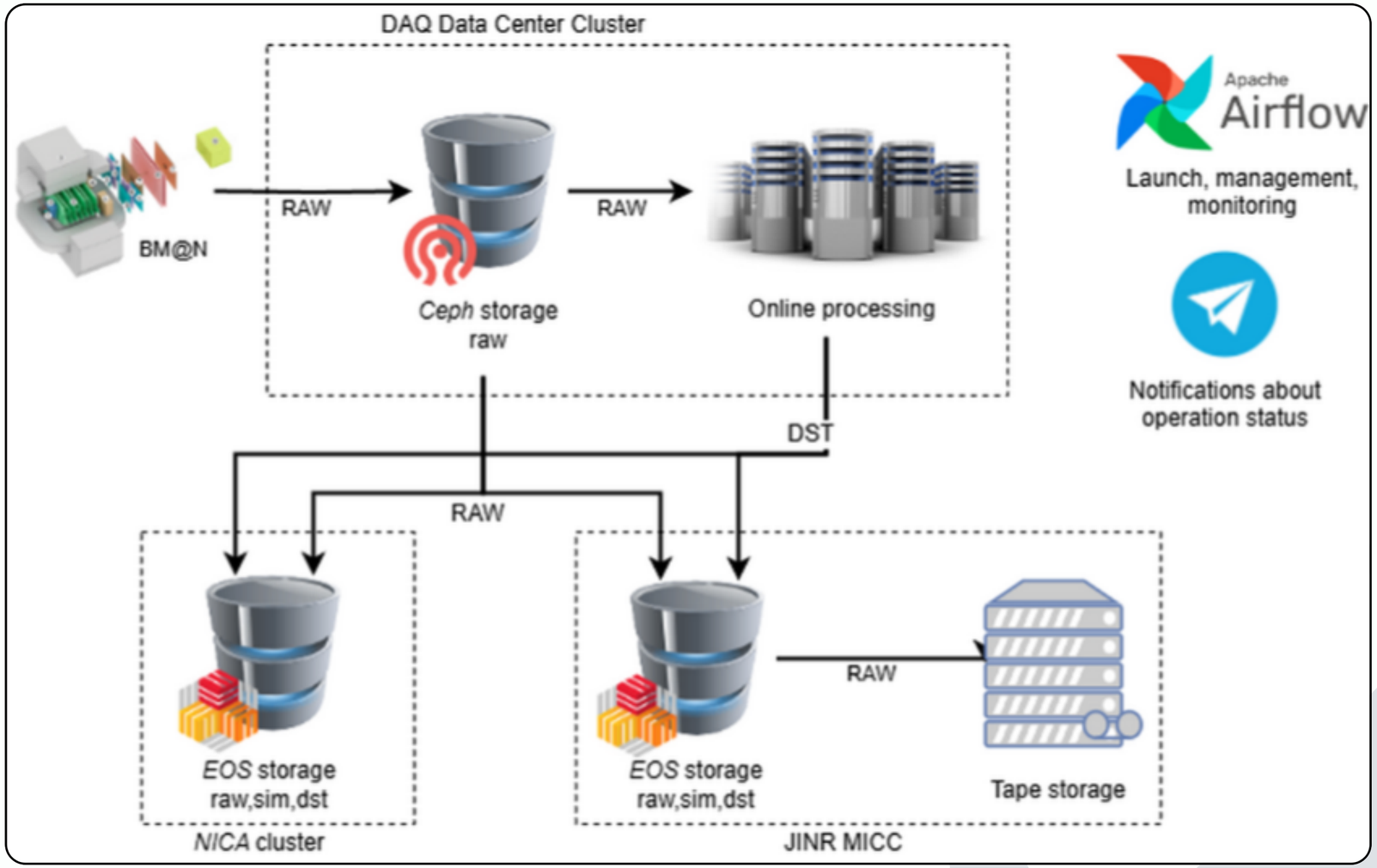
Overview of Apache Airflow-based online processing

It didn't undergo the necessary testing and **wasn't ready for use** in the current session.

The implementation used **outdated software** versions.

The code was **challenging to maintain** due to its high complexity.

The solution utilized synchronous execution, and **did not support concurrent**



https://airflow.apache.org/

Changes in the storage of raw files

Historically, all collected raw files have been stored within **a single directory**.

The number of source files has **increased significantly** due to the growth of data volume and the maximum file size limit.

A large directory imposes a **significant workload** on the limited Metadata Server resources, leading to lock storms and latency spikes with concurrent write operations. The solution is to **distribute files across multiple smaller directories** to address the metadata bottleneck.

```
/ceph/bmn/run/run9/beam
|-- run_Top_9756_ev1_p0.data
|-- run_Top_9756_ev1_p1.data
|-- run_Top_9756_ev2_p0.data
|-- run_Top_9757_ev1_p0.data
|-- run_Top_9757_ev1_p1.data
`-- run_Top_9757_ev2_p0.data
```

```
/ceph/bmn/run/run9/beam
|-- 9756
|   |-- run_Top_9756_ev1_p0.data
|   |-- run_Top_9756_ev1_p1.data
|   `-- run_Top_9756_ev2_p0.data
`-- 9757
    |-- run_Top_9757_ev1_p0.data
    |-- run_Top_9757_ev1_p1.data
    `-- run_Top_9757_ev2_p0.data
```

New Prefect-based solution

Step 1. Synchronizing new or updated folders based on the modification timestamp.

Step 2. Synchronizing all new or updated raw files for each folder detected in the previous step based on the modification timestamp and Adler32 checksum.

Step 3. Initializing replication of all raw files detected in the previous step.

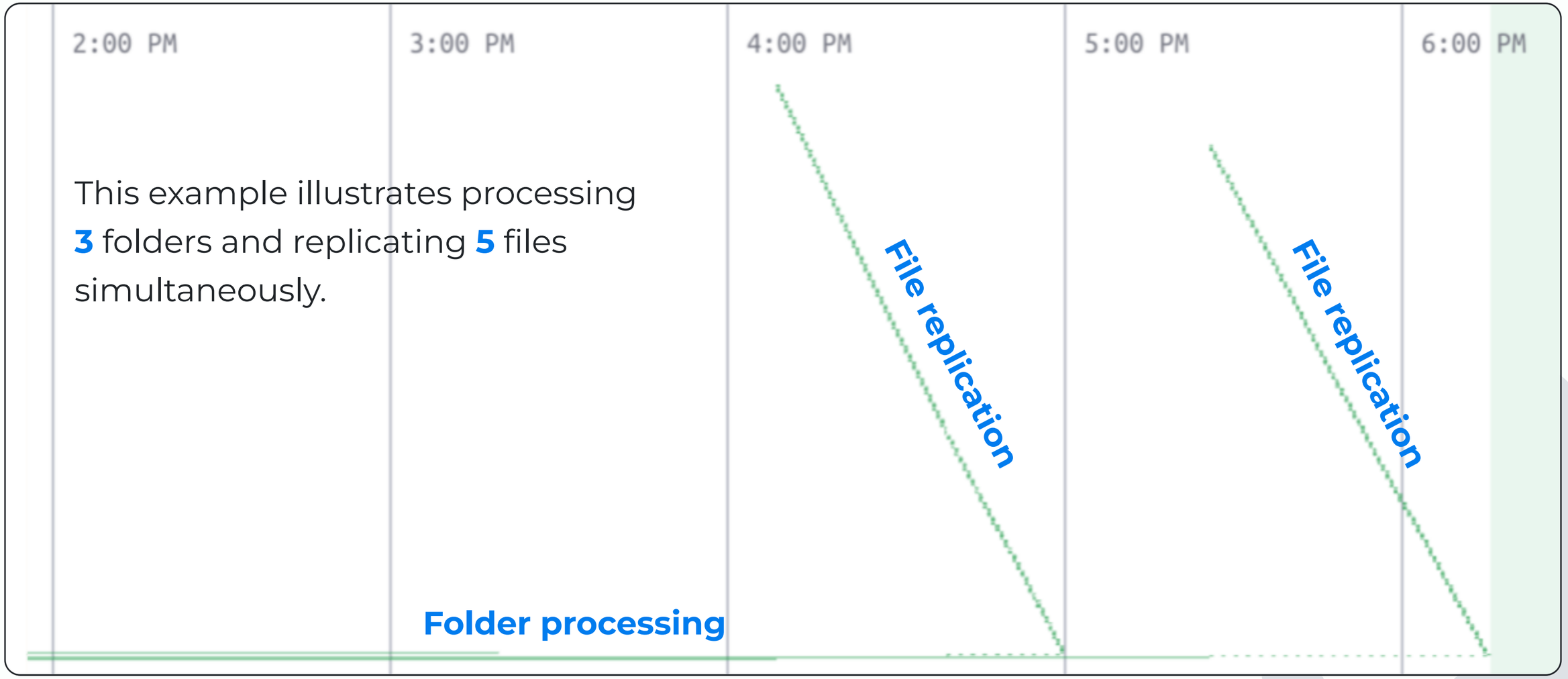
Advantages

- Uses the **latest** software versions.
- Has over **73%** test coverage.
- Uses **asynchronous execution** and supports **configurable concurrent processing** of both folders and files.

Current status

It has been deployed and tested. Processing can be started manually. Scheduling is currently not enabled, as this requires collecting statistics and discussing the number of concurrently running processes with cluster administrators.

Example


2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
This example illustrates processing
3 folders and replicating 5 files
simultaneously.
File replication
File replication
Folder processing

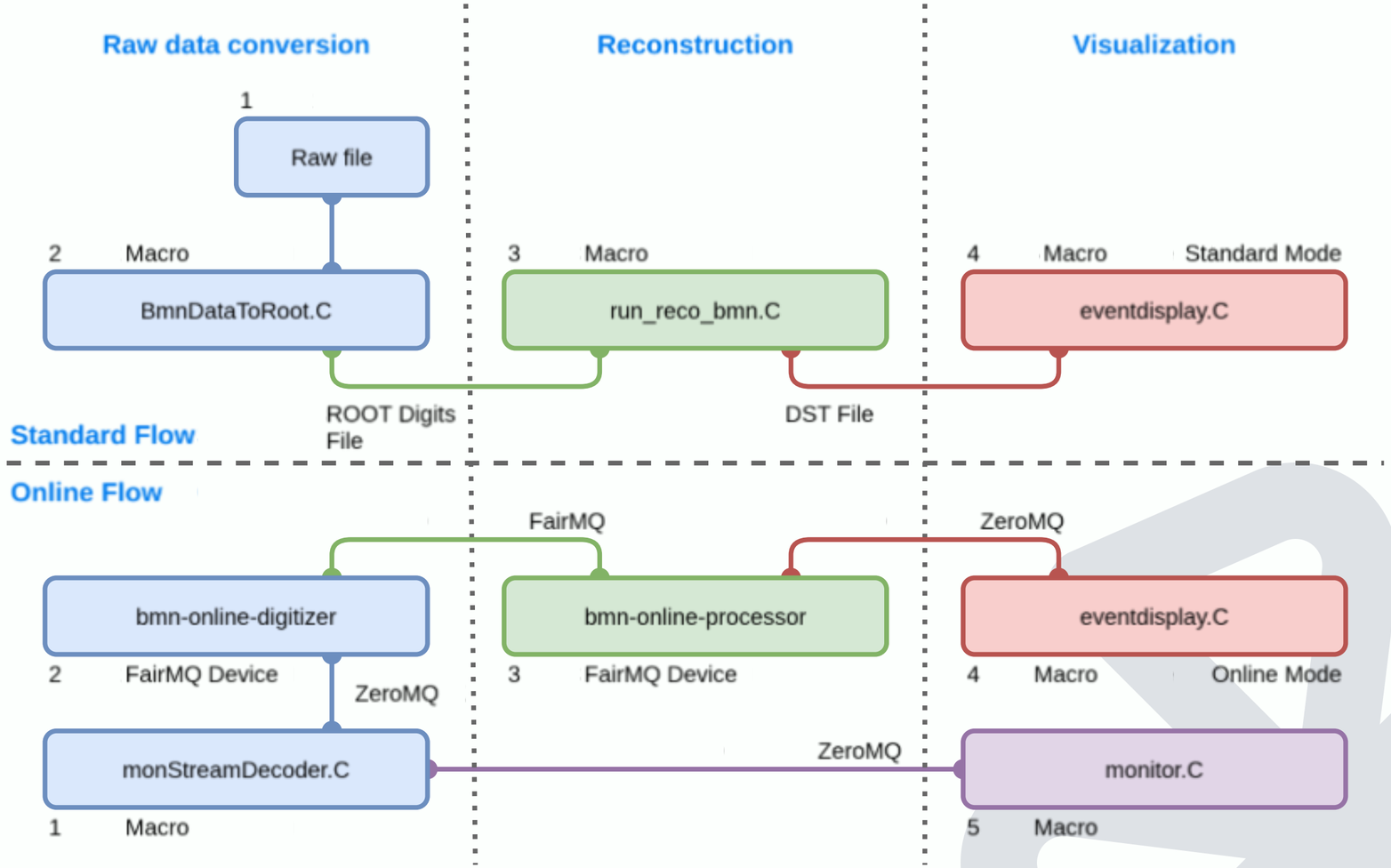
Overview of COOP-based online processing

Purpose

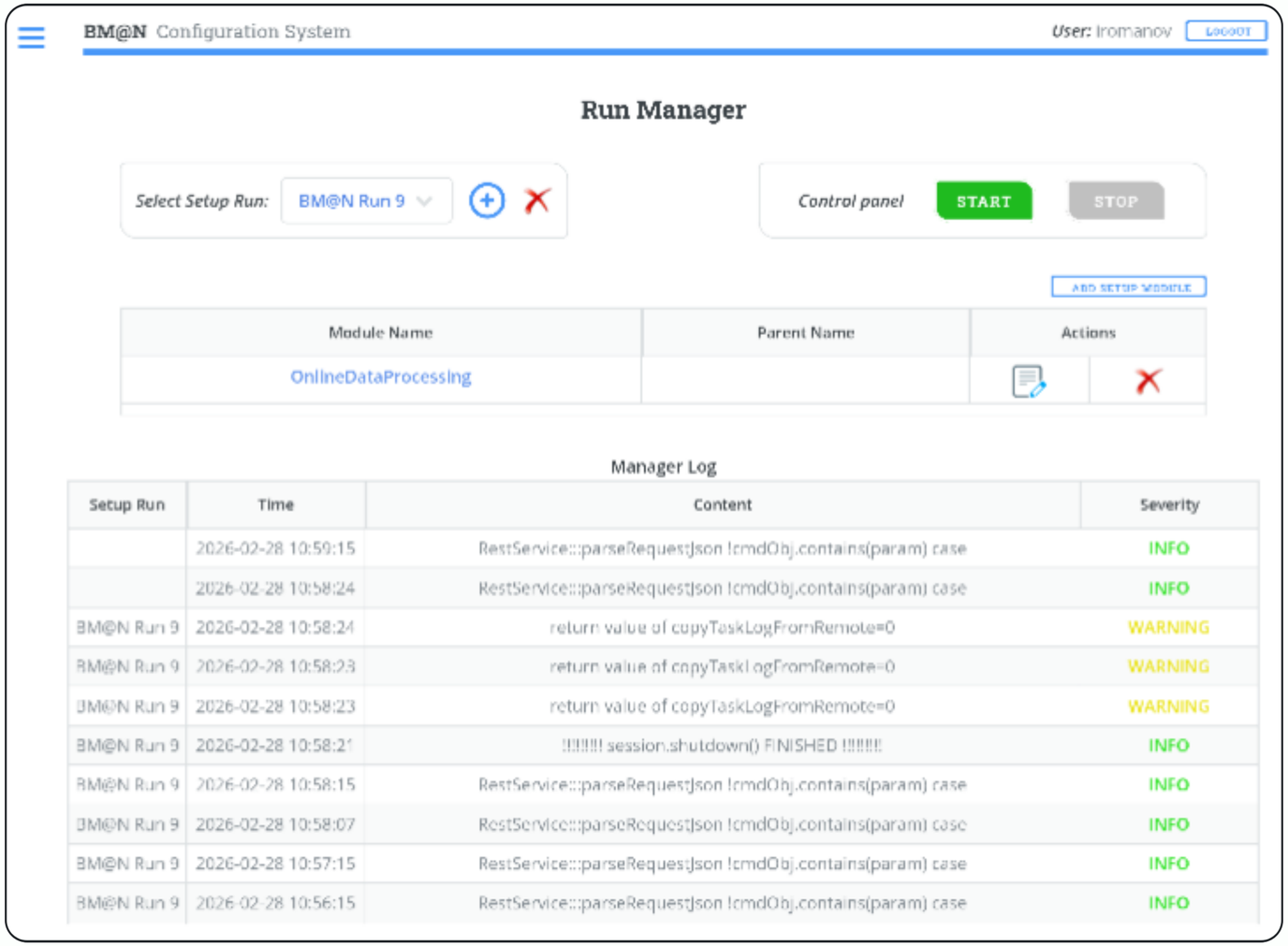
Selective data processing, which consists of raw data conversion and fast reconstruction for data quality analysis.

Current state

- No maintenance has been performed since the previous session.
- It has not yet been tested in real conditions.



Example


BM@N Configuration System
User: lromanov
LOGOUT
Run Manager
Select Setup Run:
BM@N Run 9
Control panel
START
STOP
ADD SETUP MODULE
Module Name
Parent Name
Actions
OnlineDataProcessing
Manager Log
Setup Run
Time
Content
Severity
2026-02-28 10:59:15 RestService::parseRequestJson !cmdObj.contains(param) case INFO
2026-02-28 10:58:24 RestService::parseRequestJson !cmdObj.contains(param) case INFO
BM@N Run 9 2026-02-28 10:58:24 return value of copyTaskLogFromRemote=0 WARNING
BM@N Run 9 2026-02-28 10:58:23 return value of copyTaskLogFromRemote=0 WARNING
BM@N Run 9 2026-02-28 10:58:23 return value of copyTaskLogFromRemote=0 WARNING
BM@N Run 9 2026-02-28 10:58:21 !!!!!!! session.shutdown() FINISHED !!!!!!! INFO
BM@N Run 9 2026-02-28 10:58:15 RestService::parseRequestJson !cmdObj.contains(param) case INFO
BM@N Run 9 2026-02-28 10:58:07 RestService::parseRequestJson !cmdObj.contains(param) case INFO
BM@N Run 9 2026-02-28 10:57:15 RestService::parseRequestJson !cmdObj.contains(param) case INFO
BM@N Run 9 2026-02-28 10:56:15 RestService::parseRequestJson !cmdObj.contains(param) case INFO

Current work focus

New Prefect-based online processing

- Enable scheduled running of workflows.
- Handling file processing errors using a dedicated workflow.
- Adding replication to the CICC cluster.
- Adding archiving to magnetic tape storage.
- Initialization of file processing using DIRAC.

COOP-based online processing

- Update the reconstruction device to reflect the new logic of the current session.

Thank you for **your attention**!

