The ALICE Experiment Control System in LHC Run 3

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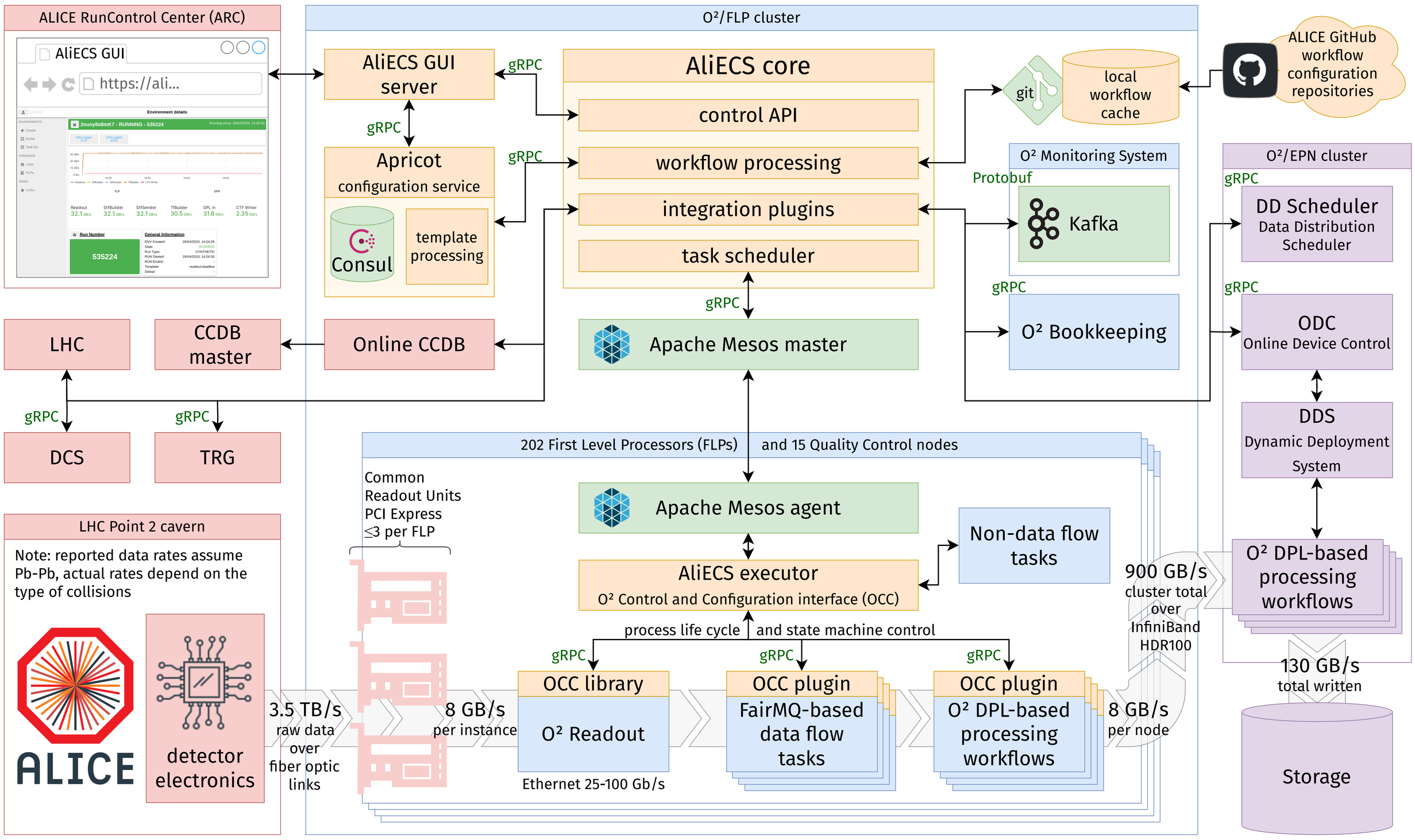


The ALICE Experiment Control System

The ALICE Experiment at CERN's Large Hadron Collider (LHC) has undergone a major upgrade during LHC Long Shutdown 2 in 2019-2021, which includes a new computing system called O² (Online-Offline). To ensure the efficient operation of the upgraded experiment and of its newly designed computing system, a reliable, high performance, full-featured experiment control system has also been developed and deployed at LHC Point 2.

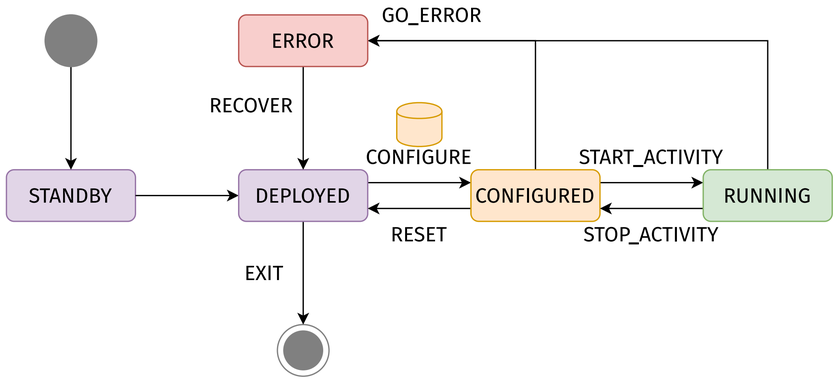
The ALICE Experiment Control System (AliECS) is a microservices-oriented system based on state-of-the-art cluster management technologies that have recently emerged in the distributed and high-performance computing ecosystem. It is designed, developed and maintained as a comprehensive solution and single entry point for control of experiment data acquisition (up to 3.5 TB/s) and processing.

AliECS Overview

Most AliECS components are written in Go and use gRPC for inter-process communication. In order to seamlessly interface with O² data flow tasks, AliECS includes a C++ library as well as a FairMQ plugin for task configuration and state machine control. AliECS includes the following components:

- **AliECS core** the main service that includes workflow processing, task deployment and control, and integration with other systems
- **Apricot - a processor and repository of configuration templates** the single point of truth for ALICE O²/FLP configuration, including AliECS configuration, hardware inventory, and task configuration templates and payloads
- **AliECS executor** one per cluster node, manages the life cycle and controls the state machine of data flow tasks
- **AliECS GUI** the web-based graphical user interface[4], used by the ALICE RunControl Center shift crew and experts to interact with AliECS
- **coconut - a control and configuration utility** the command-line equivalent to the AliECS GUI
- **OCC - O² control and configuration library and plugin** loadable components that allow AliECS to interface with controllable tasks and drive their state machine

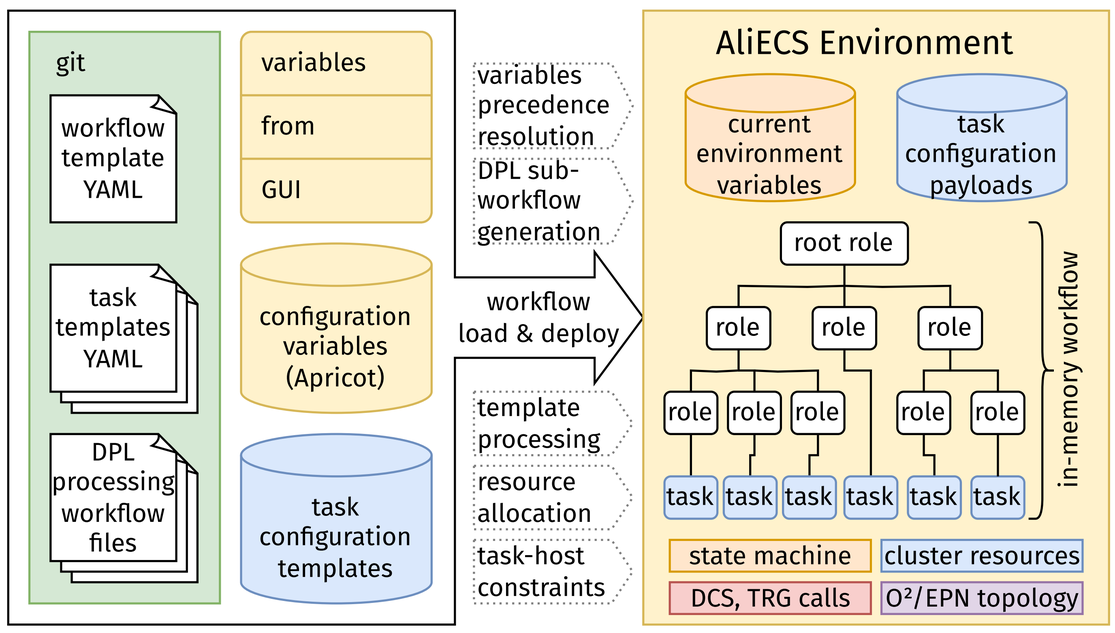
The AliECS core exchanges control commands with the executors to manage the deployment of thousands of tasks throughout the O²/FLP cluster, and to drive the state machine of those tasks that have one.



AliECS Operation

The AliECS core acquires workflow and task configuration information from configuration storage by way of Apricot, a configuration front-end microservice. This configuration information includes configuration templates for each kind of data flow task, as well as variables that affect AliECS behavior.

The main unit of data taking activity in AliECS is an *environment*, an abstraction that includes a state machine, a data-driven workflow, its tasks, and its configuration. Environments are generated from *workflow templates*, versioned YAML files sourced from git repositories through an ad-hoc repository access layer. Workflow templates include the runtime-configurable structure of a data flow, along with information on the input widgets to display in the AliECS GUI, abstract data flow connections between tasks, and any constraints on task deployment in the O²/FLP cluster.



AliECS takes advantage of Apache Mesos for cluster resource management, and uses gRPC whenever possible as an industry standard solution for inter-process communication. This includes most integration components for systems such as DCS, TRG, Bookkeeping, and control of downstream data processing facilities in the O²/EPN cluster. Fine-grained control of the interaction with such external facilities is possible within workflow template files. The same files also make it possible to expose configuration parameters for external facilities to the AliECS GUI.

By the beginning of 2023 AliECS, along with the O² system has enabled ALICE to reach over 90% running efficiency in production.

References

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