CTA Array Control And Data Acquisition in Switzerland

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cherenkov telescope array

ABSTRACT

The Cherenkov Telescope Array (CTA) will operate several types of telescopes and cameras. The individual camera trigger rates will vary greatly – from 0.6 to 15 kHz – while the content of the raw data will be heterogeneous. Raw data streams of up to 24 Gbps per telescope must be handled efficiently, from the camera front-ends down to the on-site repository and real-time analysis. Activities related to array data handling being carried out in Switzerland are presented in this poster.

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INTRODUCTION

We are developing an Array Data Handler - ADH architecture composed of several low-level components under the control of a top-level supervisor (fig. 1). The science data handler - SDH (fig. 2) retrieves event data from Cherenkov cameras' servers and processes it until it can be written to persistent storage. The Auxiliary data handler – AUXDH writes data from devices other than the Cherenkov Cameras. The Software Array Trigger (SWAT) and Data Volume Reduction (DVR) library are developed by our Polish[1] and German[2] partners respectively. There will be one ADH instance started for each sub-array.

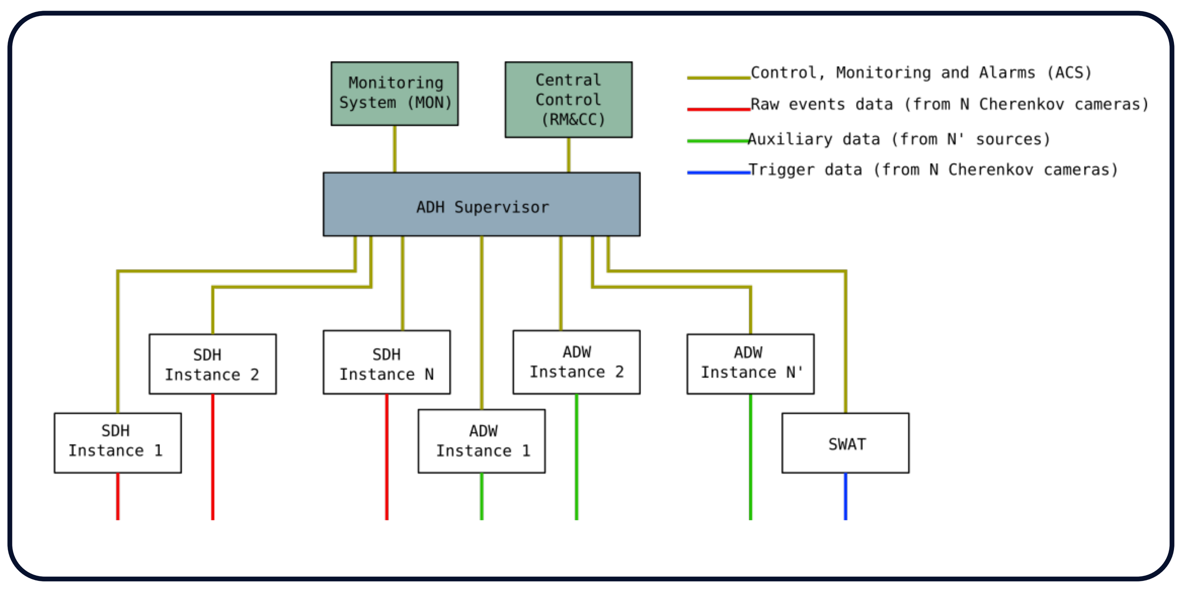

Fig. 1: Overview of the science data handling architecture

CAMERA SERVER READOUT

Camera interfacing is done via Google's protocol buffers and ZeroMQ data transfer libraries. This interface is currently in production at the Large-Sized Telescope (LST1) prototype and operates up to 9 Gbps per stream. Four parallel streams each going through a different 10 Gbps Ethernet interface are used to handle the 24 Gbps of data produced by the telescope. It is foreseen that Medium-Sized Telescopes will use two times 10 Gbps interfaces, while several Small-Sized Telescopes will use a single interface.

ACKNOWLEDGEMENTS

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PROCESSING FACILITIES

The SDH component runs the DVR library and lossless compression to be applied to all events. These processes can be time consuming and thus unlikely to run in real-time, on a single CPU core. To cope with this constraint, SDH are implemented as parallel pipelines running in their own threads. It forwards the unsorted events to the Science Alert Generation module, and sorts and writes the compressed data to disk.

Integration to Alma Common Software (ACS) is done separately from the main, low-level component development. All commands and outputs are abstracted away in the main code, and instantiated either with standard POSIX handles, or to the ACS infrastructure. This improves the development productivity by decoupling from ACS at development time.

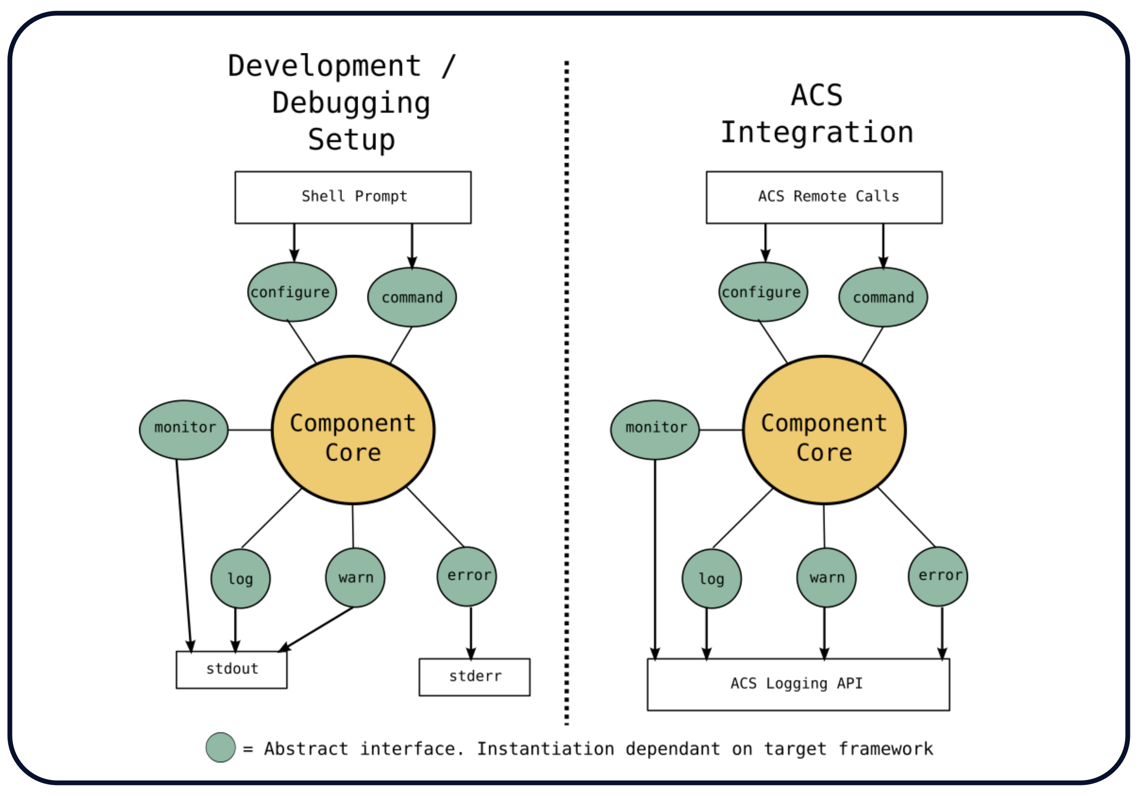

Fig. 3: ACS integration strategy. Every low-level component can be tested in a stand-alone version.

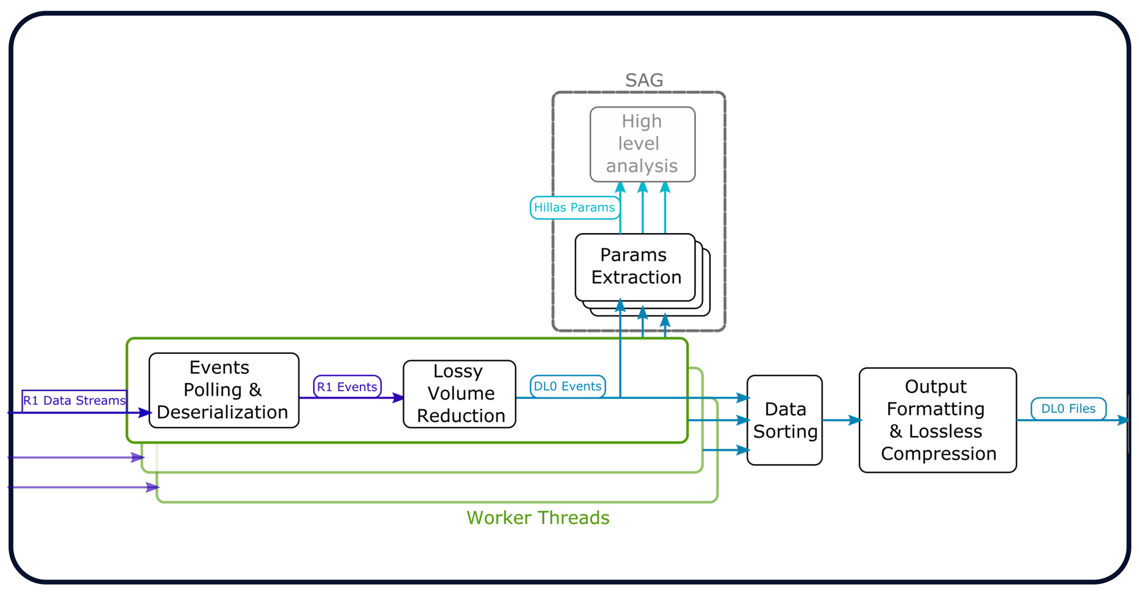

Fig. 2:Overview of the science data handler data flow. Please note that the Lossy volume reduction library is developed elsewhere

INTERFACE TO THE ON-SITE REPOSITORY

The output format currently implemented is compressed FITS (ZFITS). Numerous compression algorithms are available in our writer, from well-established schemes like Gzip to more recent implementations like Zstandard. There are even fully custom schemes, which currently outperform classical algorithms.

A simplified implementation of the ADH and a ZFITS reader for ctapipe were implemented for LST1. To avoid unnecessary developments, the final implementation will reuse as much code as possible. In the Python interface the data is read and uncompressed by C++ code before being given to the python wrapper as serialized protocol buffer format. A lightweight Python layer then decodes this binary block and delivers it to the expected ctapipe structure.

1. Our partner in Poland is the Centrum Astronomiczne im. M. Kopernika Zakład Astrofizyki – CAMK Toruń
2. Our partner in Germany is the Max-Planck-Institut für Kernphysik – MPIK Heidelberg