V Congreso de la Red Mexicana Científica y Tecnología para ALICE-LHC (Red ALICE)

ALICE-DCS Upgrade

Summary of the Integration of the Detector Control System (DCS) in the new Online-Offline system (O^2)

Juan Carlos Cabanillas Noris

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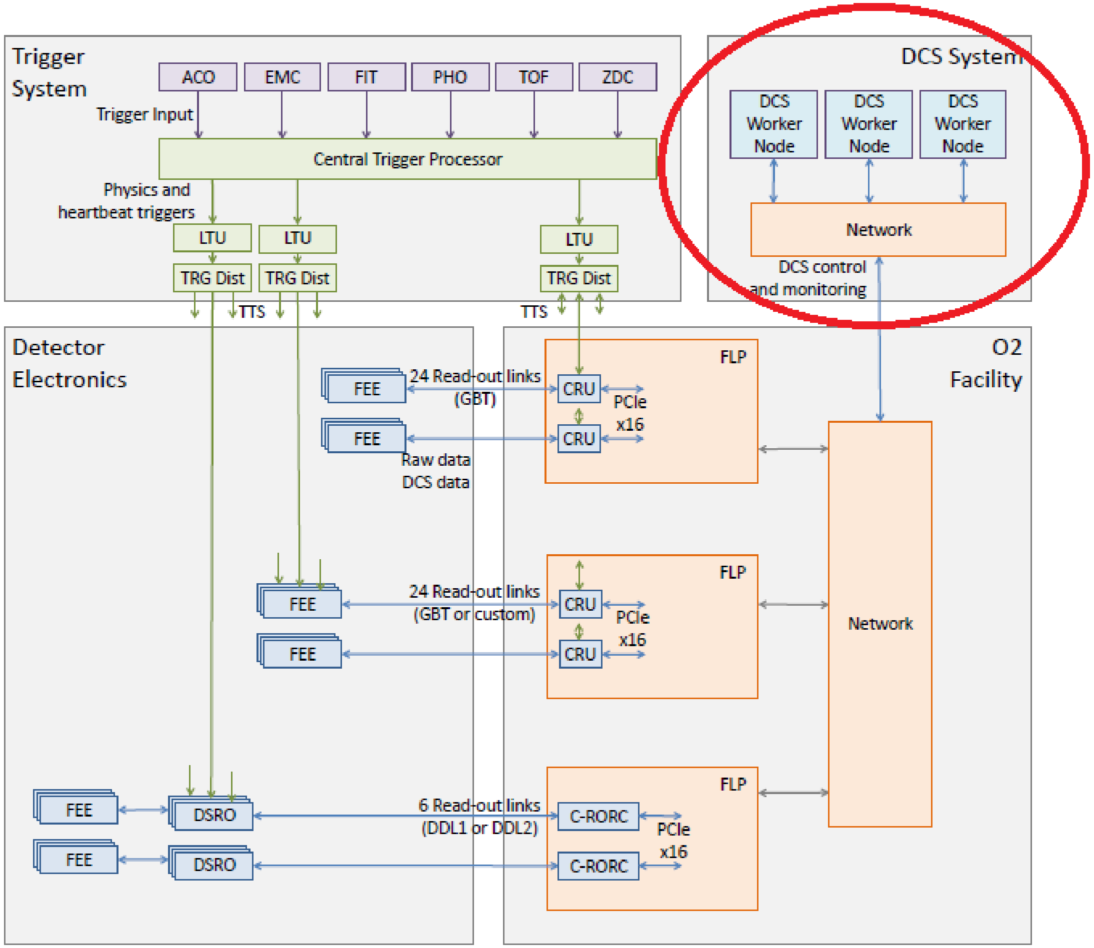
Main Operating Features for LHC-RUN3

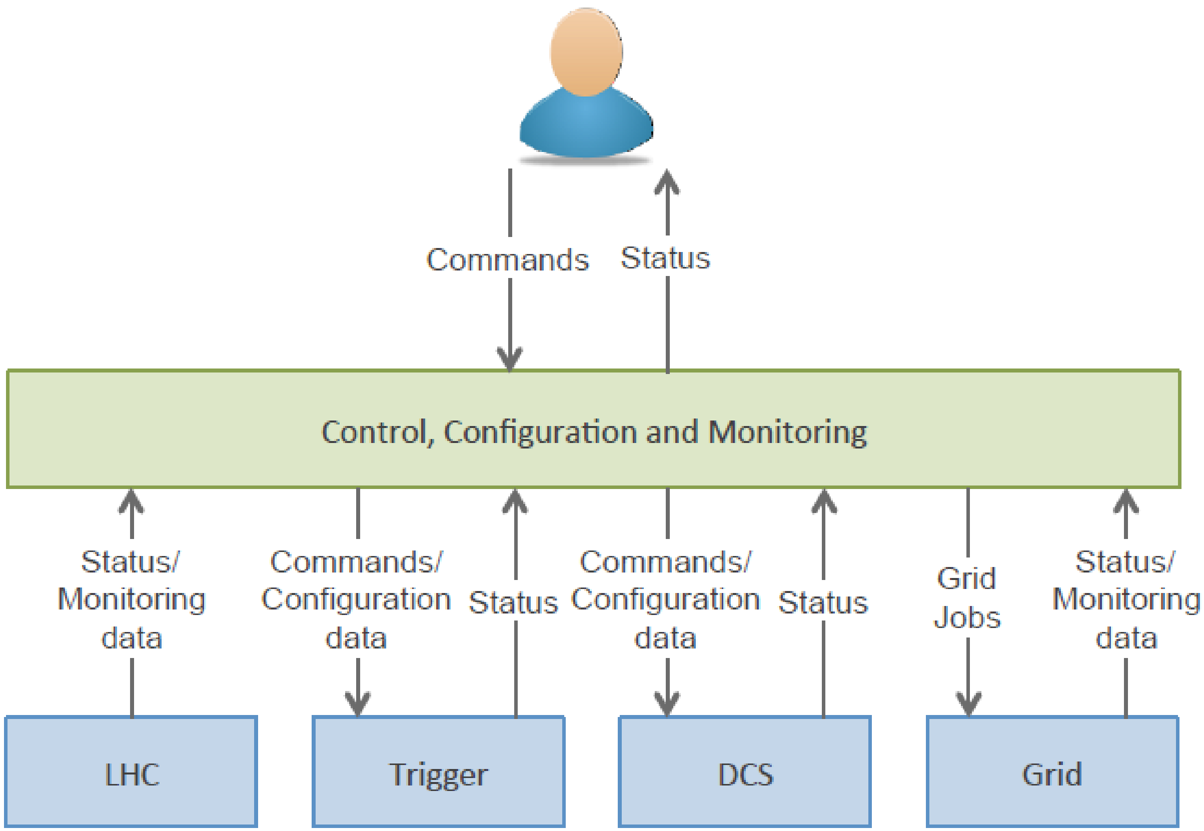
- The interaction rates at LHC in ALICE during the Run3 period will increase by a factor of 100.
- The upgraded ALICE trigger system supports both continuously read-out and triggered detector.
- The ALICE computing upgrade concept consist of transferring all detector data to the computing system.
- This new approach merges the online and offline roles into one system, named O^2.

Common Read-out Unit (CRU)



Detector read-out and interfaces of the O^2 system with the trigger, detector electronics and DCS

Facility Control, Configuration and Monitoring



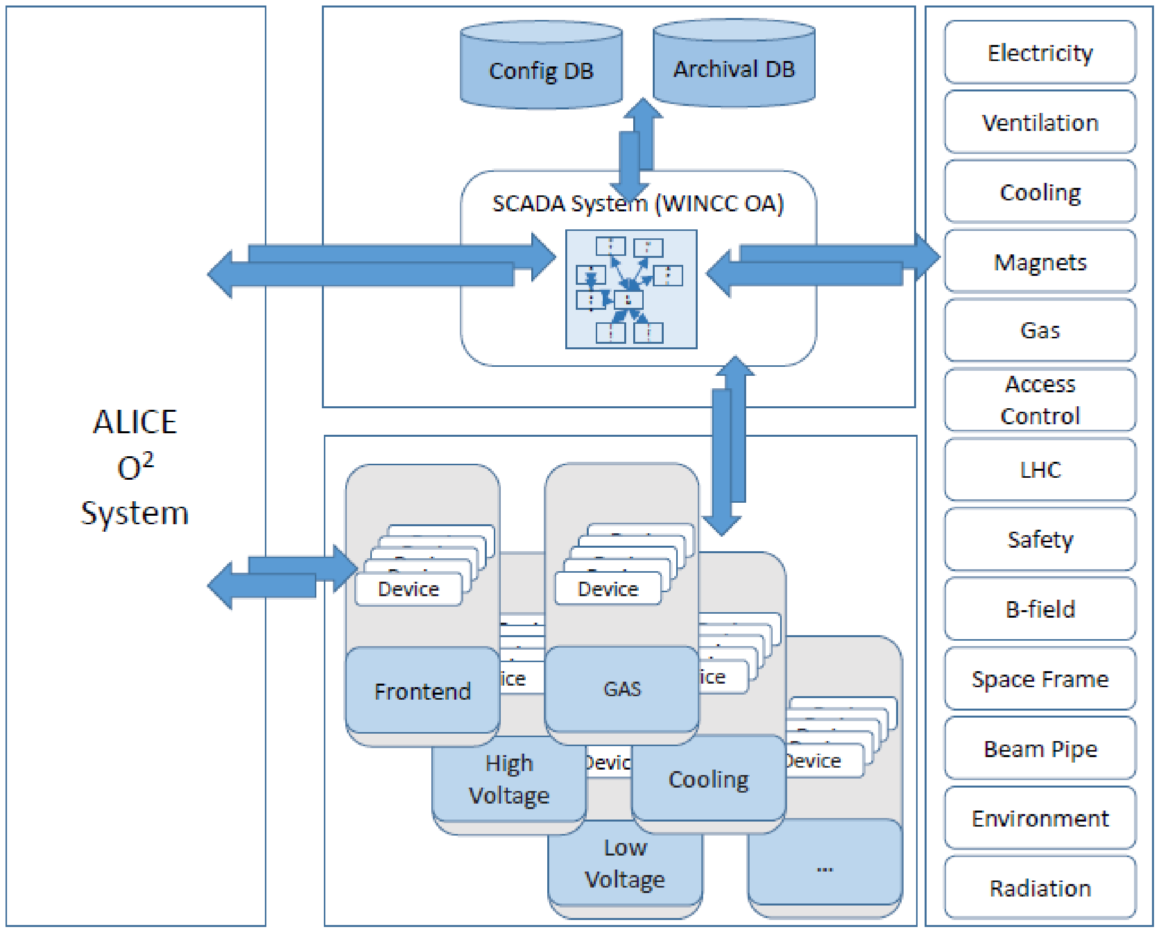
CCM interfaces with external systems

- For the global operation of ALICE, the CCM systems interface with the Trigger and DCS systems.
- …to send commands, transmit configuration parameters and receive status and monitoring data.
- It also interfaces with the LHC to automate certain operations and keep a record of data taking conditions.

Detector Control System (DCS)

- The upgrade of the online and offline computing into the O^2 system will modify some of the interfaces of the DCS.
- The DCS data are processed in the Central Supervisory Control and Data Acquisition (SCADA) system.
- WINCC Open Architecture (WINCC-OA®).
- Provided by SIEMENS.

Detector Control System (DCS)



DCS interfaces with detector devices, external services and the O^2 system

Detector Control System (DCS)

- The detectors added or upgraded during the LS2 will make a massive use of *GBT*-based read-out links.

- These links are interfaced to the O^2 system and are used for transferring both *physics* and *control data*.

- The electronics of these detectors will therefore be accessed by the DCS through the O^2 system.

@ GBT: GigaBit Transceiver

Detector Control System (DCS)

- The operational limits, device settings and configuration parameters are stored in the *configuration database* or directly in the WINCC-OA® systems.

- All parameters tagged for archival are sent to the *archival database* (ORACLE).

- The stored data are available for later retrieval either directly from WINCC-OA® or by external clients.

Detector Control System (DCS)

- The DCS interacts with external systems and services such as: cooling, safety and gas.

- The data exchanged between the DCS and the O^2 system can be divided into two categories:
  - *conditions data*
  - *configuration data*.

- The synchronization between the DCS and O^2 components is achieved using the Finite-State Machine (FSM) mechanism.

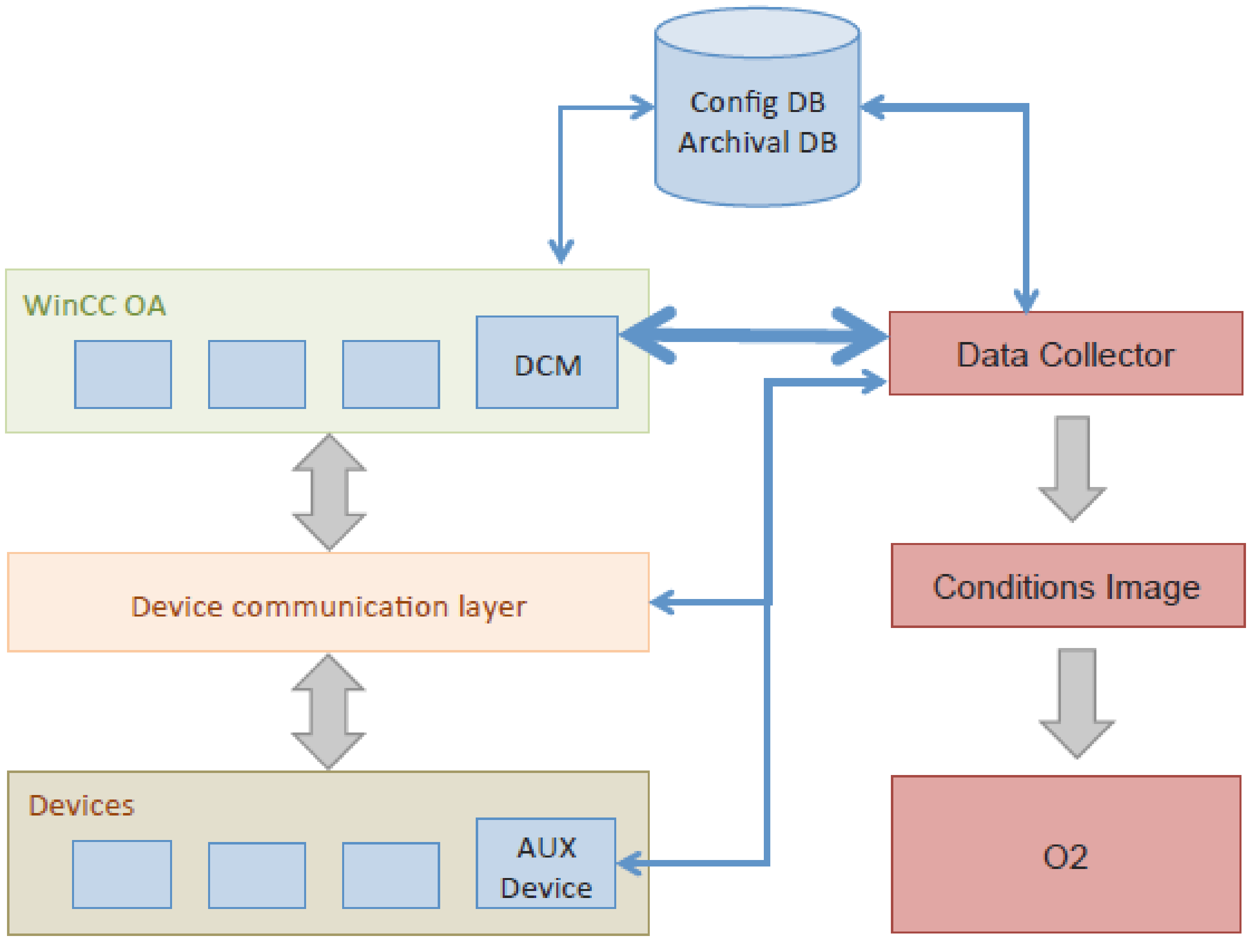
DCS-O^2 communication interfaces

- The *conditions data* are collected from devices such as temperature or humidity probes, power supplies or frontend cards.

- To isolate the O^2 system from DCS implementation details, a *Data Collector* process is implemented.

- The *Data Collector* connects to all detector systems and acquires available conditions data.

DCS-O^2 communication interfaces



The DCS Data Collector and DCS Access Points

@ DCM: Data Collector Manager

DCS-O^2 communication interfaces

Collector-Detector Connection

- Any change in monitored values is pushed to the *Data Collector* by the data publisher.
- At startup, the *Data Collector* consults the DCS *configuration* and *archival* databases and finds the physical location of each data point.
- Collected values are stored in a formatted memory block, called the *Conditions Image* (CI).

DCS-O^2 communication interfaces

Collector-Detector Connection

- Each data frame, covering *50 ms* of data taking must be completed with a block of about 100,000 DCS parameters to allow for reconstruction in the O^2 facility.

- ADAPOS will manage the transmitting *conditions data* from ALICE-DCS to the O^2 infrastructure, where it will be used in the reconstruction of physics data from the experiment.

DCS-O^2 communication interfaces

Front-end modules → DCS Link

- The frontend modules connected to the O^2 system via the GBT links are in a special category of devices.

- Physical access to these devices is achieved via the FLPs, which are not controlled by the DCS.

- A *dedicated interface* based on client-server architecture is implemented both on the DCS and FLP sides.

DCS-O^2 communication interfaces

Archiving

- To save bandwidth, only values that have changed during the actual read-out cycle are published.
- Updating this data in WINCC-OA® is therefore different for each channel.
- On each value change, the *Data Collector* is notified and the Conditions Image is updated.
- For stable channels, the value update occurs in average once every few seconds.

Conclusions

- The conditions data handling and front-end electronics access represent the two main fields of new DCS developments for the LHC-RUN3.

- Access to new front-end modules will be shared between the DCS and the Data acquisition.

- The latter will allow the development of mechanisms to enable communication between the DCS and the hardware.

References

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[3] ALICE Collaboration. O^2 : A novel combined online and offline computing system for the ALICE Experiment after 2018. Journal of Physics: Conference Series 513 (2014) 012037. URL: http://iopscience.iop.org/article/10.1088/1742-6596/513/1/012037/pdf

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[7] Lång, J., Augustinus, A., Bond, P. M., Chochula, P., Lechman, L. M., Pinazza, O., & Kurepin, A. N. ADAPOS: An Architecture for Publishing ALICE DCS Conditions Data.

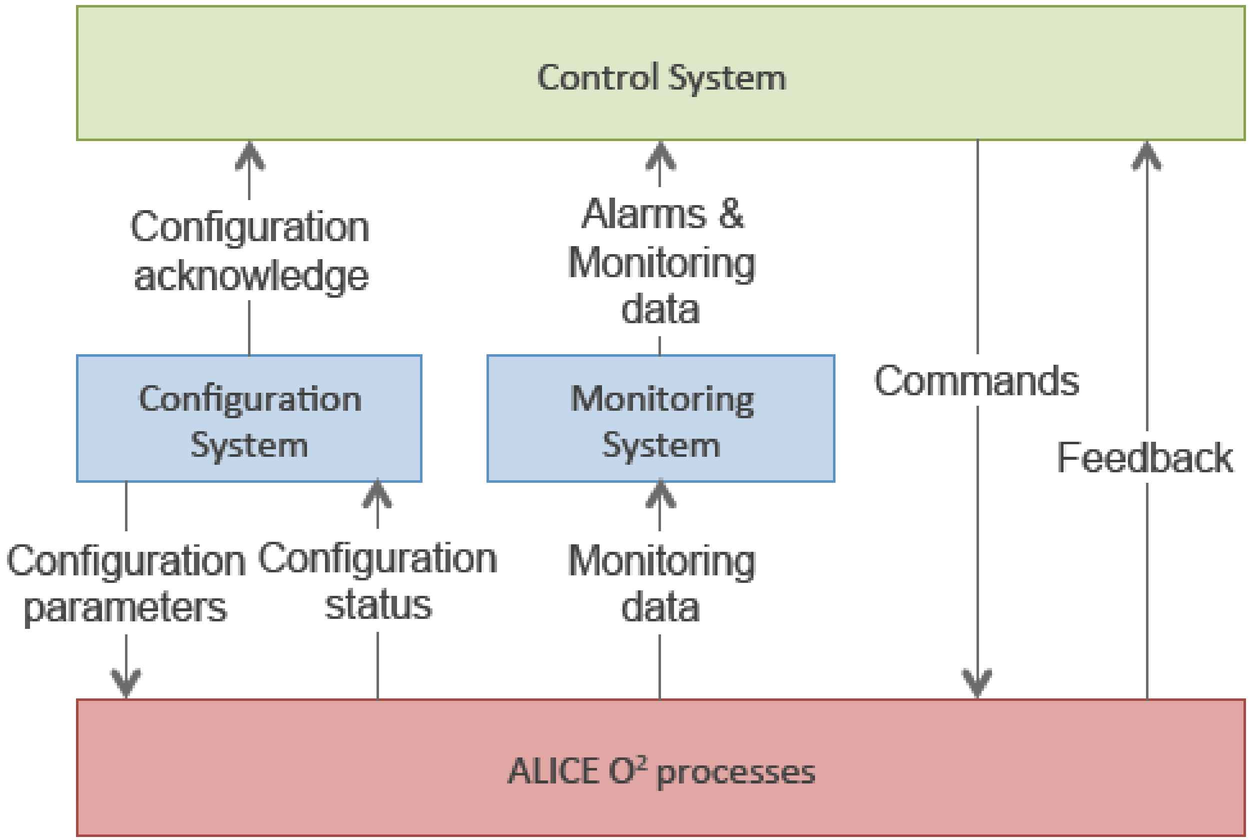
Back-up Slides

Facility Control, Configuration and Monitoring

- The Control, Configuration and Monitoring (CCM) components of the O^2 system act as a tightly-coupled entity with the role of supporting and automating day-to-day operations.

  - The *Control system* is responsible for coordinating all the O^2 processes according to system status and monitoring data.
  - The *Configuration system* ensures that both the application and environmental parameters are properly set.
  - The *Monitoring system* gathers information from the O^2 system with the aim of identifying unusual patterns and raising alarms.

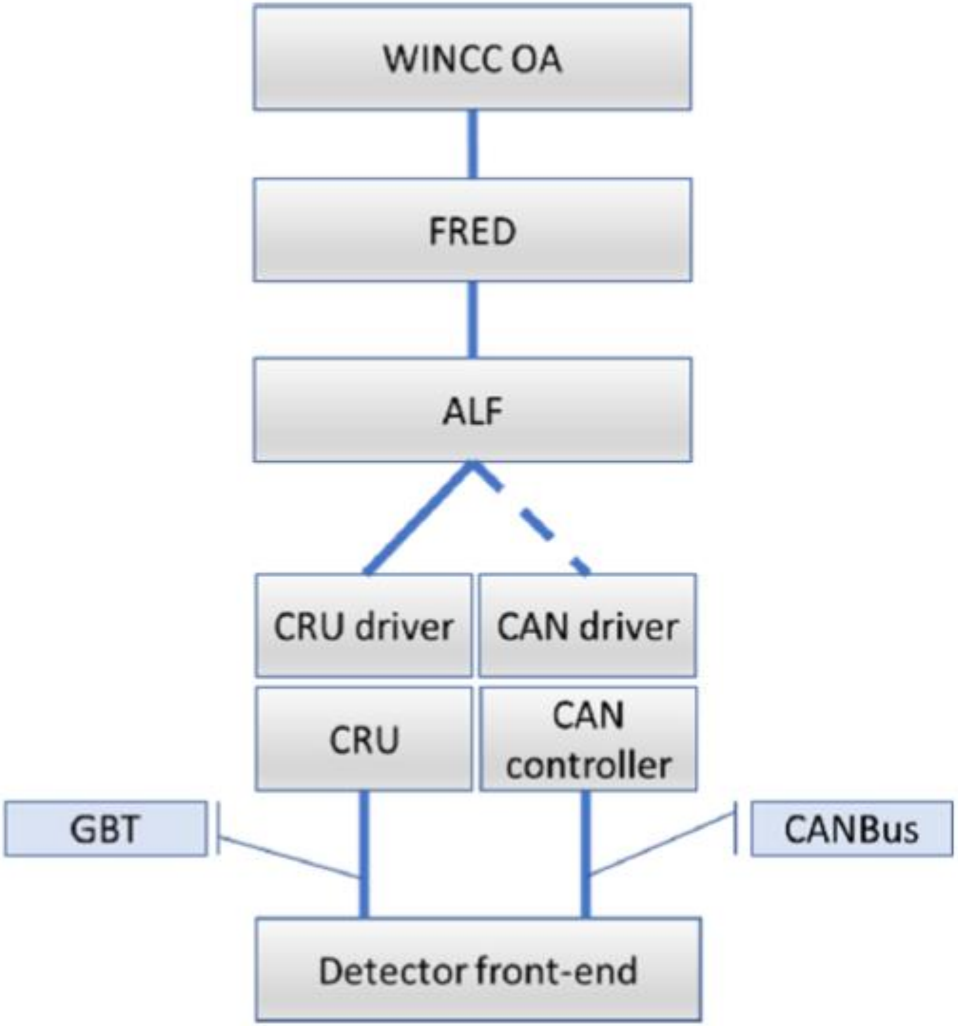
Facility Control, Configuration and Monitoring



Overview of relationship between CCM systems

Detector Control System (DCS)

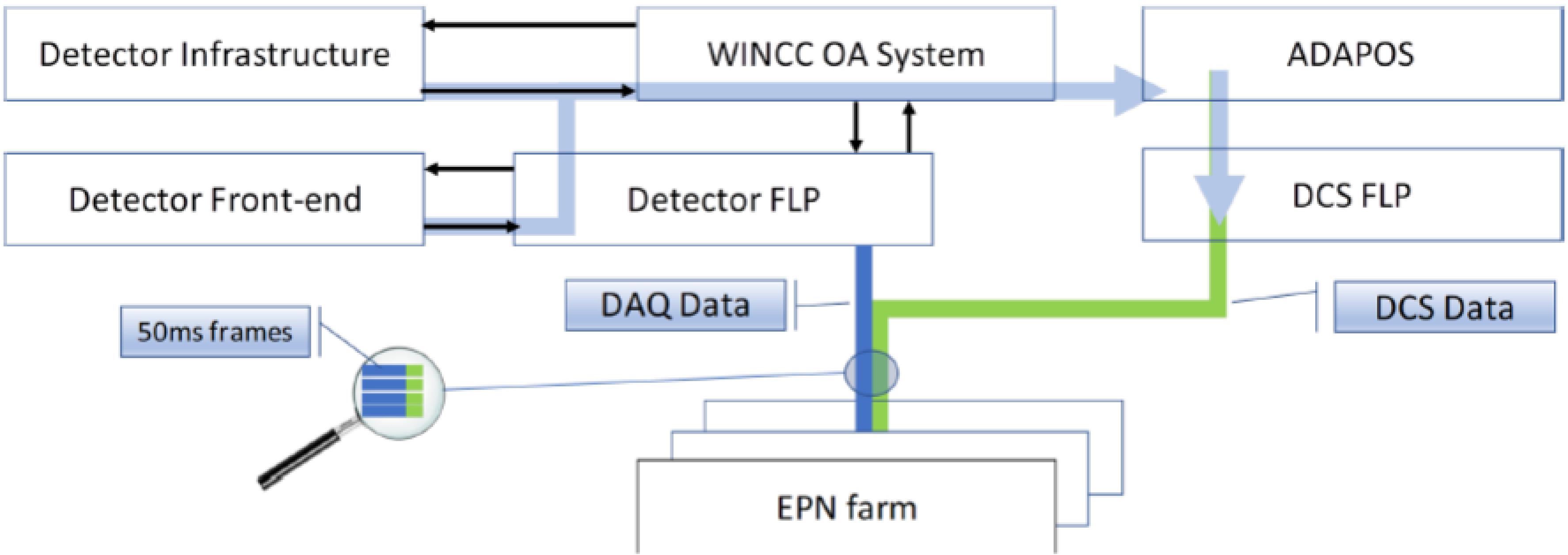
- The DCS ensures safe, reliable, and uninterrupted operation of the experiment.
- It also serves as an important communication exchange point, providing vital information for:
  - data for detector operation
  - physics analysis
  - safety systems
  - external services, including the LHC.



The ALF-FRED architecture of the DCS [6]

- The ALF-FRED architecture decouples the front-end details from the high level SCADA system.
- Separating this task into 3 layers of software – the drivers, the ALF and the FRED

@ FRED (Front-End Device)
@ ALF (Alice Low Level Front-end)
@ CRU (Common Readout Units)



The DCS dataflow in the O2 architecture

Detector Control System (DCS)

- All devices are continuously monitored by WINCC-OA® and acquired values are compared to predefined thresholds.

- In case of significant deviations from nominal settings, the SCADA system can take automatic remedial action, or alert the operator.

Detector Control System (DCS)

- The *detector conditions* data as well as *parameters acquired from external systems* are transmitted to the O^2 farm at regular time slots via a dedicated First Level Processor (FLP).

- The transmitted data frames contain the full map of all monitored parameters.

- These conditions data are required by the O^2 system for the online reconstruction.

DCS-O^2 communication interfaces

DCS → Front-end modules Link

- DCS data produced by the frontend modules are transmitted to the CRU in dedicated DCS frames which are interleaved with standard data traffic.
- An FLP side process strips the DCS information from the data stream and publishes the received values.
- The client process on the DCS side subscribes to the publications and injects all values into the standard DCS processing stream.

DCS-O^2 communication interfaces

DCS → Front-end modules Link

- The same mechanism is implemented for data which need to be sent from DCS to the frontend modules, including register settings and on/off commands.
- The DCS server contacts the FLP maintaining the physical connection with the target devices and sends a command and the required parameters to the listening client.
- The FLP side client ensures the transfer of this data to the target device over the GBT link.

DCS-O^2 communication interfaces

Archiving

- To overcome the limitation of delay in some parameters, dedicated measuring devices based on fast hardware have been installed.
- These devices monitor the fast changing parameters and publish them to the *Data Collector*.
- In parallel, all values are time-stamped and sent to WINCC-OA® to be archived along with standard data.

DCS-O^2 communication interfaces

Archiving

- To create the initial *Conditions Image*, the Data Collector contacts all relevant WINCC-OA® systems and retrieves all current values.

- The value update request is executed for each conditions parameter at least once, at the Data Collector startup.

- If high update frequencies are required, the access points can be implemented outside WINCC-OA®.

DCS-O^2 communication interfaces

Archiving

- Finally, an access point attached to the archival database gives access to historical values.
- The *Data Collector* can retrieve DCS data for any period of time and make them available to consumers.
- This working mode is reserved mainly for interfaces to external systems, such as the LHC.

DCS-O^2 communication interfaces

Collector-Detector Connection

- A dedicated O^2 process retrieves conditions data from the CI and inserts them into the DCS data frames to be injected to the O^2 system via a dedicated FLP.

DCS-O^2 communication interfaces

Collector-Detector Connection

- A part of ADAPOS updates an *Full Buffer Image* (FBI), which represents a snapshot of the state of DCS.
- Other ADAPOS application keeps sending FBIs to the DAQ readout application at regular intervals.