Design of the data quality control system for the ALICE O²

ALICE
ALICE is the heavy-ion detector designed to study the physics of strongly interacting matter and the quark-gluon plasma at the CERN LHC. The experiment is designed to cope with very high particle multiplicities.

O² project
A major upgrade of the experiment is planned after LS2. In order to cope with the huge amount of detectors’ data (>3 TB/s), as well as with the continuous readout of the Time Projection Chamber, it is necessary to compress the data intelligently by performing online their reconstruction and to upgrade the Online and Offline Computing to a new common system called O².

Data Quality Control
- Combined online Data Quality Monitoring and offline Quality Assurance
- Critical to quickly identify and overcome problems and to provide good quality data for physics analyses
- Necessary to ensure that the calibration and reconstruction behave as expected, especially when running synchronously with the data taking

- Requirements
  - 25000 QC objects, updated every minute (~400 objects/s)
  - More than 100 tasks, most running in parallel (up to 1500 instances per task)
  - QC objects: scalars, ROOT histograms and trees
  - QC Objects size:
    - 1kB – 50MB

Mergers
- Goal: Fast and efficient merging of the QC objects arising from parallel and distributed analysis
- Functionality:
  - Collecting and sending QC objects via ZeroMQ sockets
  - Serializing, deserializing and merging of the QC objects
- Results:
  - Merger CPU usage reaches maximum for the topology with 1 merger and 10 producers of the QC objects (1kB / QC object, ~2.5 MB / s / producer) due to ZeroMQ socket buffer overflow
  - Merger CPU is not utilized for the large QC object of 50 MB (1 merger, 2 producers) while waiting for the objects

QC prototype benchmark
- Goals: assess code developed so far for the framework and identify possible bottlenecks
- 1-30 tasks producing 1-1000 histograms checked by 1-10 checkers running 1000 checks
- Results:
  - System scales up to 500 histograms/second
    - Already above the requirements
  - Database is a potential bottleneck
  - CPU (framework) <10% of a single core
  - Memory scales linearly with size of objects

Future work
- Continue study of merger topologies
- Bring together merger and framework
- Attach to a real data source
- Integrate with the Experiment Control System
- Implement correlation and trending
- Implement Web GUIs able to display and manipulate ROOT objects
- Commission with detectors

Glossary
- LHC: Large Hadron Collider
- ALICE: A Large Ion Collider Experiment
- O²: Online-Offline system
- QC: Data Quality Control
- LS2: Long Shutdown 2