Data handling and transfer in the LHCb experiment

RT NPSS Real Time 2007

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LHCb in a nutshell

- One of the 4 major LHC experiments at CERN
- 2 proton beams colliding at 7 TeV each
- Studies CP violation of b-mesons and other rare decays
- Single arm spectrometer
- 1.000.000 channels to be read out at 40 MHz
- Foreseen to start at the end of 2007

DAQ System overview

File management requirements

Functional requirements:

- Replicating files to the CERN Tape storage system (CASTOR)
- Creating appropriate entries in the GRID file catalogue (database that serves as a translation between the logical file name and its physical location)
- Managing metadata information and replicating it inside the LHCb Bookkeeping Database (database storing all information needed for all physics computing)

Operational requirements:

- Integration with the Experiment Control System
- Error recovery, redundancy
- Interface to external Online applications
- Automated and flexible management

File management implementation overview

ECS = **E**xperiment **C**ontrol **S**ystem

DIRAC = **D**istributed **I**nfrastructure
with **R**emote **A**gent **C**ontrol

CASTOR = **C**ERN **A**dvanced **S**TORage
Manager

Legend:

Data flow

Control communication

File handling communication

Online Run Database

- Centralized point of file management.
- Simple but extensible SQL structure (not fixed yet!).
- Oracle database backend.
- Control and behaviour implemented using a server side Python application (using the cxOracle module)
- The management application is stateless, can be run in multiple instances for redundancy.

File states inside DAQ System

- Pseudo Petri net diagram models file behaviour
- Asynchronous transitions from one state to another
- File accesses are reference counted
- Timestamps are used for error recovery
- File migration is decoupled from file usage
- File deletion triggered by low space on the Online SAN

Online Run Database interfaces

Several possibilities for accessing/controlling the Online Run Database:

- **XMLRPC** interface for the server controlling the actual Oracle database. Required for communication with the DIRAC software. Also useful for creating various scripts/applications (C/C++, Python, etc)
- **DIM** interface to the Experiment Control System (PVSS). DIM is exposed to Python as an ordinary C library.
- **Oracle** specific tools for performing “big” changes to the database (e.g. table modification, backup restoring).
- **HTTP** based interface that can be opened using a common web browser. Should be the most used tool for viewing the content of the database and for small administrative tasks. Supports access control.

File handler

- Functionality:
 - file copy to CASTOR (triggering file migration)
 - updates the LHCb Bookkeeping DB
 - file deletion
 - error recovery
- Can be run in multiple instances on different machines if needed. The Online Database is the central point of synchronization (e.g. assures that the same file is not migrated simultaneously by two independent processes).
- Can run independently of the other online processes (independent of the Data Writer).
- Integrated with the ECS using DIM

WEB Management Tool

SeaMonkey

File Edit View Go Bookmarks Tools Window Help

Back Forward Reload Stop http://lbonrac2/test.py Search Print

Home Bookmarks Red Hat, Inc. Red Hat Network Support Shop Products Training

The Large Hadron Collider beauty experiment

for precise measurements of CP violation and rare decays

[View Table](#) [SQL Queries](#) [Logout](#)

Select Table: Autorefresh: Records: Sort by: Order: Filter by: Value:

Nr	Name	Stream	RunNumber	State	TimeStamp	FileID		
1	run_00002_stream_test_writer_id_00166	test_writer	2	9	2006-11-02 18:54:55	166	Modify	Delete
2	run_00002_stream_test_writer_id_00167	test_writer	2	9	2006-11-02 18:57:04	167	Modify	Delete
3	run_00002_stream_test_writer_id_00169	test_writer	2	9	2006-11-02 19:00:44	169	Modify	Delete
4	run_00002_stream_test_writer_id_00171	test_writer	2	9	2006-11-02 19:04:58	171	Modify	Delete
5	run_00002_stream_test_writer_id_00181	test_writer	2	9	2006-11-02 19:11:32	181	Modify	Delete
6	run_00002_stream_test_writer_id_00182	test_writer	2	9	2006-11-02 19:09:22	182	Modify	Delete
7	run_00002_stream_test_writer_id_00183	test_writer	2	9	2006-11-02 19:10:39	183	Modify	Delete
8	run_00002_stream_test_writer_id_00184	test_writer	2	9	2006-11-02 19:12:41	184	Modify	Delete
9	run_00002_stream_test_writer_id_00185	test_writer	2	9	2006-11-02 19:14:36	185	Modify	Delete
10	run_00002_stream_test_writer_id_00186	test_writer	2	9	2006-11-02 19:16:22	186	Modify	Delete
11	run_00002_stream_test_writer_id_00187	test_writer	2	9	2006-11-02 19:28:31	187	Modify	Delete
12	run_00002_stream_test_writer_id_00188	test_writer	2	10	2006-11-02 19:25:14	188	Modify	Delete
13	run_00002_stream_test_writer_id_00189	test_writer	2	9	2006-11-02 19:22:03	189	Modify	Delete
14	run_00002_stream_test_writer_id_00190	test_writer	2	9	2006-11-02 19:24:08	190	Modify	Delete
15	run_00002_stream_test_writer_id_00191	test_writer	2	9	2006-11-02 19:25:55	191	Modify	Delete
16	run_00002_stream_test_writer_id_00192	test_writer	2	9	2006-11-02 19:27:43	192	Modify	Delete
17	run_00002_stream_test_writer_id_00193	test_writer	2	9	2006-11-02 19:29:25	193	Modify	Delete
18	run_00002_stream_test_writer_id_00194	test_writer	2	9	2006-11-02 19:31:23	194	Modify	Delete
19	run_00002_stream_test_writer_id_00195	test_writer	2	10	2006-11-02 19:38:37	195	Modify	Delete
20	run_00002_stream_test_writer_id_00196	test_writer	2	9	2006-11-02 19:34:36	196	Modify	Delete
21	run_00002_stream_test_writer_id_00197	test_writer	2	9	2006-11-02 19:36:38	197	Modify	Delete
22	run_00002_stream_test_writer_id_00198	test_writer	2	10	2006-11-02 19:43:10	198	Modify	Delete

Tests

- **Functionality:** files generated and transferred to CASTOR. Complete software chain is working.
- **Stability and error recovery:**
 - Tested behaviour and error recovery in case of simulated errors.
- **Performance:**
 - Load simulated for the data handler and Online Run Database on a single machine. Maximum data handling was 10^3 more than needed:
 - files managed at a rate of 30/s
 - CPU utilisation ~80%
 - I/O ~4 MB/s
 - files entries: 8 million

Thank you!

Any questions?

(LHCb Cavern)