DIRAC Data Management: consistency, integrity and coherence of data

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CHEP'07 VICTORIA, BC

International Conference on Computing in High Energy and Nuclear Physics

2-7 Sept 2007 Victoria BC Canada

Outline

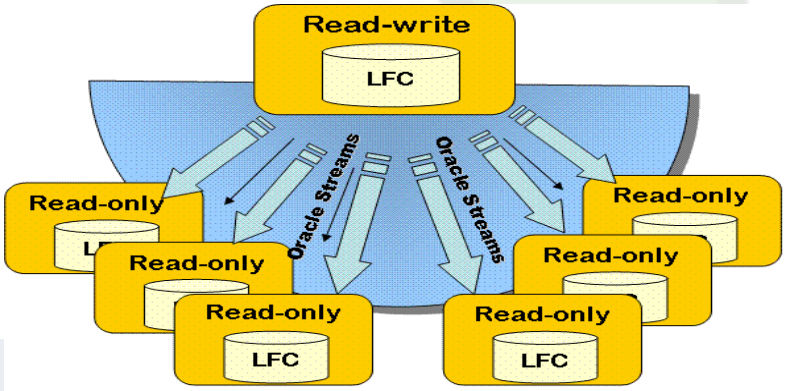
- DIRAC Data Management System (DMS)
- LHCb catalogues and physical storage
- DMS integrity checking
- Conclusions

DIRAC Data Management System

- **DIRAC project (Distributed Infrastructure with Remote Agent Control) is the LHCb Workload and Data Management System**
  - DIRAC architecture based on Services and Agents
    - **see A. Tsaregorodsev poster [189]**
- **The DIRAC Data Management System deals with three components:**
  - **File Catalogue:** allows to know where files are stored
  - **Bookkeeping Meta Data DB (BK):** allows to know what are the contents of the files
  - **Storage Elements:** underlying Grid Storage Elements (SE) where files are stored
  - **consistency between these catalogues and Storage Elements is fundamental for a reliable Data Management**
    - **see A.C Smith poster [195]**

LHCb File Catalogue

- LHCb choice: LCG File Catalogue (LFC)
  - it allows registering and retrieving the location of physical replicas in the grid infrastructure.
  - It stores:
    - file information (lfn, size, guid)
    - replica information
- DIRAC WMS uses LFC information to decide where jobs can be scheduled
  - Fundamental to avoid any kind of inconsistencies both with storages and with related catalogues (BK Meta Data DB)
- Baseline choice for DIRAC: central LFC
  - one single master (R/W) and many RO mirrors
  - coherence ensured by single write endpoint



Registration of replicas

- GUID check: before the registration in the LCG File Catalogue, at the beginning of transfer phase, the existence of file GUID to be transferred is checked
  - to avoid GUID mismatch problem in registration
- After a successful transfer, LFC registration of files is divided into 2 atomic operations
  - booking of meta data fields with the insertion in the dedicated table of lfn, guid and size
  - replica registration

→ **if either step fails:**

- → possible source of errors and inconsistencies
- → e.g the file is registered without any replica or with zero size

LHCb Bookkeeping Meta Data DB

- The Bookkeeping (**BK**) is the system that stores data provenience information.
- It contains information about jobs and files and their relations:
  - Job: Application name, Application version, Application parameters, which files it has generated etc..
  - File: size, event, filename, guid, from which job it was generated etc.
- The Bookkeeping DB represents the main gateway for users to select the available data and datasets.
- All data visible to users are flagged as 'Has replica'
  - All the data stored in the BK and flagged as '**having replica**', must be correctly registered and available in LFC.

Storage Elements

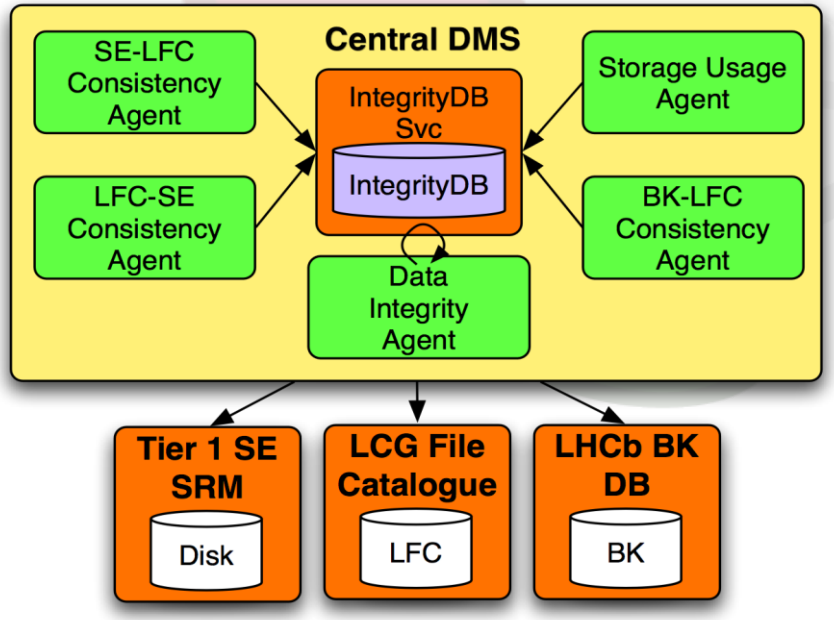
- **DIRAC Storage Element Client**
  - provides uniform access to GRID Storage Elements
  - implemented with plug-in modules for access protocols
    - srm, gridftp, bbftp, sftp, http supported
- SRM is the standard interface to grid storage
- LHCb has 14 SRM endpoints
  - disk and tape storage for each T1 site
- SRM will allow browsing the storage namespace (since SRM v2.2)
- Functionalities are exposed to users through GFAL Library API
  - python binding of GFAL Library is used to develop the DIRAC tools

Data integrity checks

- Considering the high number of interactions among DM system components, integrity checking is part of the DIRAC Data Management system.
- Two ways of performing checks:
  - those running as Agents within the DIRAC framework
  - those launched by the Data Manager to address specific situations.
- The Agent type of checks can be broken into two further distinct types.
  - Those solely based on the information found on SE/LFC/BK
    - BK->LFC
    - LFC->SE
    - SE->LFC
    - Storage Usage Agent
  - those based on a priori knowledge of where files should exist based on the Computing Model
    - i.e DST always present at all T1's disks

DMS Integrity Agents overview

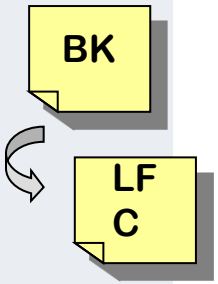
- **The complete suite for integrity checking includes an assortment of agents:**
  - Agents providing independent integrity checks on catalogs and storages and reporting to IntegrityDB
  - Further agent (Data Integrity Agent) processes, where possible, the files contained in the IntegrityDB by correcting, registering or replicating files as needed



Data integrity checks & DM Console

- **The Data Management Console is the interface for the Data Manager.**
  - the DM Console allows data integrity checks to be launched.
- **The development of these tools has been driven by experience**
  - many catalog operations (fixes)
    - bulk extraction of replica information
    - deletion of replicas according to sites
    - extraction of replicas through LFC directories
    - change of replicas' SE name in the catalogue
    - creations of bulk transfer/removal jobs

BK - LFC Consistency Agent

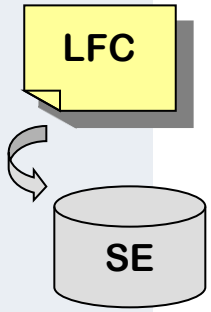


- **Main problem affecting BK: many lfns registred in the BK but failed to be registred on LFC**
  - **missing files in the LFC: users trying to select LFNs in the BK can't find any replica in the LFC**
    - Possible causes: Failing of registration on the LFC due to failure on copy, temporary lack of service..
- **BK→LFC: performs massive check on productions**
  - **checking from BK dumps of different productions against same directories on LFC**
  - **for each production:**
    - checking for the existence of each entry from BK against LFC
    - check on file sizes
  - **In case of missing or problematic files, reports to the IntegrityDB**

LFC Pathologies

- Many different possible inconsistencies arising in a complex computing model:
  - **zero size files:**
    - file metadata registred on LFC but missing information on size (set to 0)
  - **missing replica information:**
    - missing replica field in the Replica Information Table on the DB
  - **wrong SAPath:** (bugs from DIRAC old version, now fixed)
    - srm://gridka-dCache.fzk.de:8443/castor/cern.ch/grid/lhcb/production/DC06/v1-lumi2/00001354/DIGI/0000/00001354_00000027_9.digi GRIDKA-tape
  - **wrong SE host:**
    - CERN_Castor, wrong info in the LHCb Configuration Service
  - **wrong protocol**
    - sfn, rfio, bbftp…
  - **mistakes in files registration**
    - blank spaces on the surl path, carriage returns, presence of port number in the surl path..

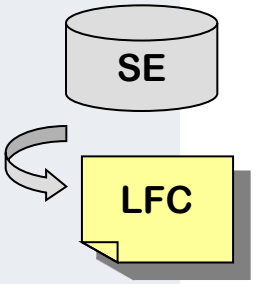
LFC – SE Consistency Agent



- LFC replicas need perfect coherence with storage replicas both in path, protocol and size:
  - **Replication issue**: check whether the LFC replicas are really resident on Physical storages (check the existence and the size of files)
    - if files are not existing, they are recorded as such in the Integrity DB
  - **Registration issues**: LFC->SE agent stores problematic files in central IntegrityDB according to different pathologies:
    - zero size files
    - missing replica information
    - wrong SA Path
    - wrong protocol

SE – LFC Consistency Agent

- Checks the SE contents against LCG File Catalogue:
  - lists the contents of the SE
  - checks against the catalogue for corresponding replicas
    - if files are missing (due to any kind of incorrect registration), they are recorded as such in the Integrity DB
  - missing efficient Storage Interface for bulk meta data queries (directory listings)
    - not possible to list the content of remote directories and getting associated meta-data (lcg-ls)
  - Further implementations to be put in place through SRM v2!!

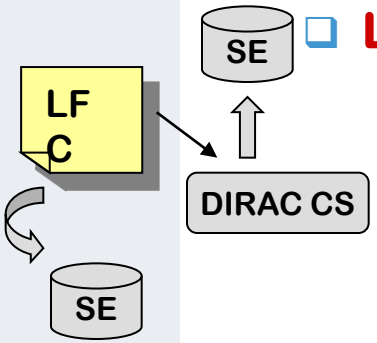


Storage Usage Agent

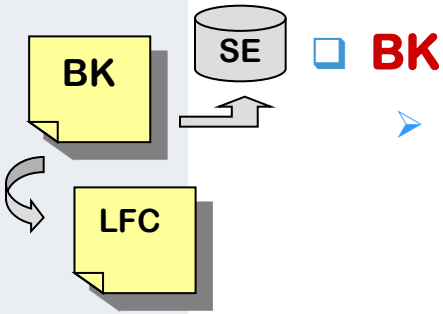
- Using the registered replicas and their sizes on the LFC, this agent constructs an exhaustive picture of current LHCb storage usage:
  - works through breakdown by directories
  - loops on LFC extracting files sizes according to different storages
  - stores information on central IntegrityDB
  - produce a full picture of disk and tape occupancy on each storage
  - provides an up-to-dated picture of LHCb's usage of resources in almost real time
- Foreseen development: using LFC accounting interface to have a global picture per site

Data Integrity Agent

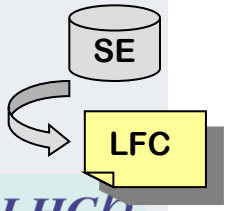
- **The Integrity agent takes actions over a wide number of pathologies stored by agents in the IntegrityDB.**
- **Action taken:**



- **LFC – SE:**
  - in case of missing replica on LFC: produce SURL paths starting from LFN, according to DIRAC Configuration System for all the defined storage elements;
    - extensive search throughout all T1 SEs
    - if search successful, registration of missing replicas.
  - same action in case of zero-size files, wrong SA-Path,..



- **BK - LFC:**
  - if file not present on LFC:
    - extensive research performed on all SEs
    - if file is not found anywhere →removal of flag 'has replica': no more visible to users
    - if file is found:→ update of LFC with missing file infos extracted from storages



- **SE – LFC:**
  - files missing from the catalogue can be:
    - registered in catalogue if LFN is present
    - deleted from SE if LFN is missing on the catalogue

Prevention of Inconsistencies

- **Failover mechanism:**
  - each operation that can fail is wrapped in a XML record as a request which can be stored in a Request DB.
  - Request DBs are sitting in one of the LHCb VO Boxes, which ensures that these records will never be lost
  - these requests are executed by dedicated agents running on VO Boxes, and are retried as many times as needed until they succeed
  - examples: files registration operation, data transfer operation, BK registration…
- **Many other internal checks are also implemented within the DIRAC system to avoid data inconsistencies as much as possible. They include for example:**
  - checking on file transfers based on file size or checksum, etc..

Conclusions

- Integrity checks suite is an important part of Data Management activity
- Further development will be possible with SRM v2 (SE vs LFC Agent)
- Most effort now in the prevention of inconsistencies (checksums, failover mechanisms…)
- **Final target: minimizing the number of occurrences of frustrated users looking for non-existing data.**

Backup

DIRAC Architecture

- DIRAC (Distributed Infrastructure with Remote Agent Control) is the LHCb's grid project
- DIRAC architecture split into three main component types:
  - Services - independent functionalities deployed and administered centrally on machines accessible by all other DIRAC components
  - Resources - GRID compute and storage resources at remote sites
  - Agents - lightweight software components that request jobs from the central Services for a specific purpose.
- The DIRAC Data Management System is made up an assortment of these components.

DIRAC DM System

- **Main components of the DIRAC Data Management System:**
  - **Storage Element**
    - abstraction of GRID storage resources: Grid SE (also Storage Element) is the underlying resource used
    - actual access by specific plug-ins
    - srm, gridftp, bbftp, sftp, http supported
    - namespace management, file up/download, deletion etc.
  - **Replica Manager**
    - provides an API for the available data management operations
    - point of contact for users of data management systems
    - removes direct operation with Storage Element and File Catalogs
    - uploading/downloading file to/from GRID SE, replication of files, file registration, file removal
  - **File Catalog**
    - standard API exposed for variety of available catalogs
    - allows redundancy across several catalogs

Data Management Clients