HEP Metadata Schema

Mòrag Burgon-Lyon[a], Tony Doyle[a], Steven Hanlon[a], Paul Millar[a], Richard St.Denis[a], Tim Barrass[b], Randolph Herber[c], Adam Lyon[c], Julie Trumbo[c] , Solveig Albrand[d], Jerome Fulchier[d] , Carmine Cioffi[e], Stephen Burke[f]

[a]University of Glasgow, Scotland, United Kingdom

[b]University of Bristol, England, United Kingdom

[c]Fermi National Accelerator Laboratory, Batavia, IL, USA

[d]LPSC, Grenoble, France

[e]University of Oxford, England, United Kingdom

[f]Ruthorford Appleton Laboratory, England, United Kingdom

Metadata is "ancillary information about stored data, which aids a user in handling it, describing it and understanding what it contains.". Metadata schema, used in new and mature High Energy Physics (HEP) experiments, is analysed by applying common use cases and reporting on the implications of implementation both from a user perspective and how the underlying metadata is held and processed by the metadata schema and systems.

1. Introduction

The core use cases for HEP Metadata have been agreed upon by the Metadata working group, a collaboration of representatives from several HEP experiments. These are reported in the All Hands submission *"The Thirteen Core Use Cases of HEP Metadata"*. Here we concentrate on the schema for the metadata addressed by the use cases. These fall into the following categories: Dataset Handling for creation and access of data and metadata; Analysis for the specific needs of physics analysis; and Job Handling for the grid aspects of submitting, querying and controlling jobs.

The experiments and data handling systems examined are as follows:

- ATLAS (A Toroidal LHC Apparatus) Experiment using AMI (ATLAS Metadata Interface) [2]
- BaBar Experiment[3], [4]
- CDF (Collider Detector at Fermilab) Experiment using SAM (Sequential data Access via Metadata) [5]
- CMS Experiment using PhEDEx (Physics Experiment Data Export) [6], TMDB (Transfer Management Database) [7], and RefDB [8]
- LHCb (Large Hadron Collider b) Experiment [9] [10]

2. ATLAS and AMI

ATLAS is a new LHC (Large Hadron Collider) experiment which uses AMI to provide access to any database. This solution is highly flexible, allowing both schema discovery and the addition of new schema at run time. For the purpose of this paper, the schema used for Data-Challenge 2 is tested against the core use cases.

3. BaBar

The BaBar experiment, based at SLAC has been collecting data since 2001, accumulating over a petabyte of physics data. Having undergone two major design iterations, initially using a commercial ODBMS (Object oriented Database Management System), the experiment now uses an open-source, file based, object persistent system. The data is log-

ically organised in several domains, with no direct cross-references. One of the key domains is the event-store, which holds the bulk of BaBar data. By contrast the bookkeeping system uses an RDBMS (Relational Database Management System) holding only 3GB of data.

4. CDF and SAM

The SAM data handling system was originally designed for use by the D0 experiment in the late nineties. It is now also used in production by CDF and other experiments such as MINOS are in the process of adopting it. The original system has a grid extension called JIM (Job and Information Management) where the combination of SAM and JIM is known as SAMGrid. The CDF experiment currently uses a number of DCAFs (Distributed CDF Analysis Farms) with SAM for data processing. Although not fully deployed as yet, SAMGrid allows jobs to run on DCAF facilities. For the purpose of this paper, the full SAM-Grid system is examined.

5. CMS

One of the four new LHC experiments, CMS uses PhEDEx for data transfer. This is comprised of: TMDB; Transfer agents; Management agents; Transfer request management tools; Local agents for local file management; and web monitoring tools. In addition RefDB, an RDBMS, is used for recording and managing all details of the physics simulation, reconstruction and analysis requests, for coordinating task assignments to world-wide distributed Regional Centres and tracing their progress.

6. LHCb

LHCb uses a two schema strategy for handling data, which is stored as key-value pairs in a Warehouse Database (WDB). A View of the data, using a different schema specialised to a specific task is used to access the data for different purposes. LHCb uses two service to access these databases. A servlet service allows dataset selection based on job provenance using a web browser and an XML-RPC service allows the data in the WDB to be changed whilst also allowing access by GANGA to the bookkeeping database.

7. Summary

All the experiments meet the needs of their users but in a variety of different ways. The older systems tend to be more monolithic, but have a wide range of functionality on offer, having had sufficient time to implement user requirements that have become apparent after the initial design phase. The newer experiments tend to follow more distributed architectures, and incorporate web services in line with the GGF (Global Grid Forum) recommendations. Features such as schema discovery, run-time schema extensibility and independence from any particular RDBMS or operating system are common. Given experiences such as those of the BaBar experiment, where data acquisition requirements have far exceeded initial expectations, this additional flexibility and extensibility in the new experiments is a sensible approach.

REFERENCES

1. S. Hanlon, *et al.*, Unlucky For Some: The Thirteen Core Use Cases of HEP Metadata
2. S. Hanlon, *et al.*, The AMI Database Schema, 2005
3. The BaBar Database home page `http://www.slac.stanford.edu/BFROOT/www/Public/Computing/Databases/index.shtml`
4. J. Becla, D. Wang, Lessons Learned Managing a Petabyte `http://www-db.cs.wisc.edu/cidr/papers/P06.pdf`
5. M. Burgon-Lyon, J. Trumbo, The SAM Database Schema, 2005
6. The PhEDEx home page `http://cms-project-phedex.web.cern.ch/cms-project-phedex/`
7. T. Barrass, S. Metson, L. Turra, CMS Data Handling: TMDB Schema and Database Interactions, 2004
8. V.Lefébure, J.Andreeva, RefDB: The Reference Database for CMS Monte Carlo Production, 2003
9. C. Cioffi, *et al.* File Metadata Management System for the LHCb Experiment, CHEP04
10. J. Closier, *et al.* Data Management: Job Configuration, Data Production, Bookkeeping, 2001