



# HARP DATA AND SOFTWARE MIGRATION FROM Objectivity TO ORACLE®



Authors: **A.Valassi**, D.Geppert, M. Lübeck, K. Nienartowicz, M. Nowak (CERN IT-DB, Geneva, Switzerland), E. Tcherniaev (CERN PH, Geneva, Switzerland), D. Kolev (University of Sofia, Bulgaria)

### MOTIVATION

End of Objectivity support at CERN in 2003

### SCOPE

- 1 - Migrate HARP data from Objectivity to the new persistency solutions based on Oracle
- 2 - Develop read-only Oracle software to allow event processing in the HARP Gaudi framework

### THREE PHASES

- 1 - Raw event data migration
- 2 - Event collection metadata migration and development of Oracle navigation software
- 3 - Condition data and software migration

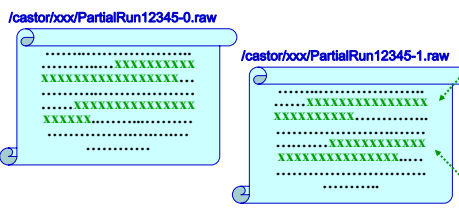
### PHASES 1 AND 2 (EVENT DATA):

#### HYBRID DATA STORE

Raw data in flat files (DATE format)

Metadata in Oracle

Similarities to the POOL data model



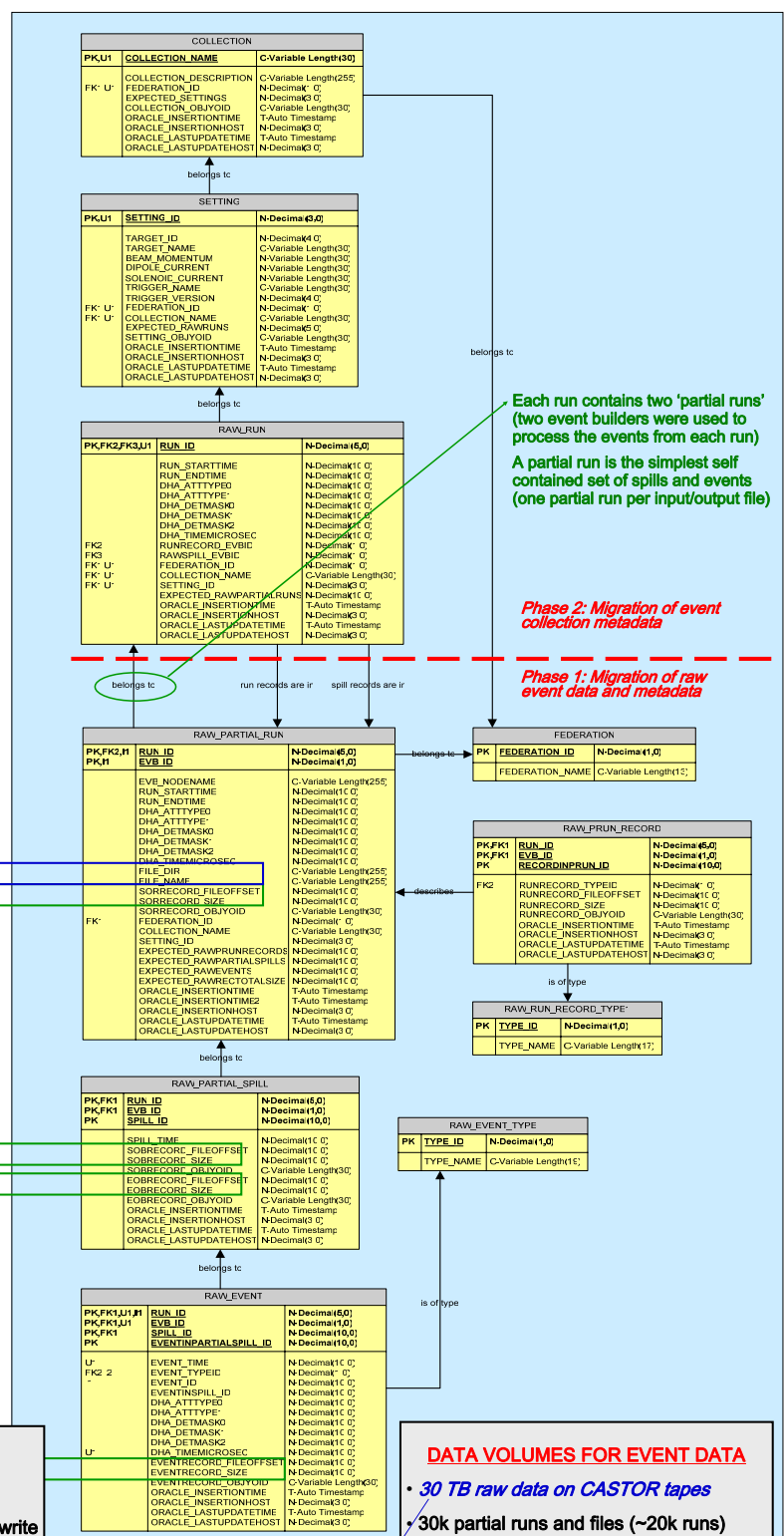
RAW_PARTIAL_RUN_EXTENDED_MV	
RUN_IC	N-Decima(5,0)
EVE_ID	N-Decima(10)
EVE_NODENAME	C-Variable Length(255)
RUN_STARTTIME	N-Decima(11,0)
RUN_ENDTIME	N-Decima(11,0)
DHA_ATTYPED	N-Decima(11,0)
DHA_ATTYPED2	N-Decima(11,0)
DHA_DETMSK0	N-Decima(11,0)
DHA_DETMSK1	N-Decima(11,0)
DHA_DETMSK2	N-Decima(11,0)
DHA_TIMERMICROSEC	N-Decima(11,0)
FILE_DIR	C-Variable Length(255)
FILE_NAME	C-Variable Length(255)
SORRECORD_FILEOFFSET	N-Decima(11,0)
SORRECORD_SIZE	N-Decima(11,0)
SORRECORD_OBVOID	C-Variable Length(30)
FEDERATION_ID	N-Decima(4,0)
COLLECTION_NAME	C-Variable Length(30)
SETTING_ID	N-Decima(6,0)
EXPECTED_RAWPRUNRECORDS	N-Decima(11,0)
EXPECTED_RAWPARTIALSPILLS	N-Decima(11,0)
EXPECTED_RAWEVENTS	N-Decima(11,0)
EXPECTED_RAWRECTOTALSIZE	N-Decima(11,0)
ORACLE_INSERTIONTIME	T-Auto Timestamp
ORACLE_INSERTIONTIME2	T-Auto Timestamp
ORACLE_INSERTIONHOST	N-Decima(3,0)
ORACLE_LASTUPDATEHOST	N-Decima(3,0)
RAWPRUNRECORDS_NUMBER	N-Variable Length(0)
RAWPRUNRECORDS_RECISIZE	N-Variable Length(0)
RAWPARTIALSPILLS_NUMBER	N-Variable Length(0)
RAWPARTIALSPILLS_RECISIZE	N-Variable Length(0)
RAWEVENTS_NUMBER	N-Variable Length(0)
RAWEVENTS_RECISIZE	N-Variable Length(0)
RAWPHYSEVENTS_NUMBER	N-Variable Length(0)
RAWPHYSEVENTS_RECISIZE	N-Variable Length(0)
RAWCALEVENTS_NUMBER	N-Variable Length(0)
RAWCALEVENTS_RECISIZE	N-Variable Length(0)

Example of materialized view: summary table for queries such as

- eventsInRun()
- physEventsInRun()
- calibEventsInRun()

### ORACLE FEATURES USED

- Integrity constraints (foreign keys)
- Views, materialized views, query rewrite
- Logical and physical partitioning for all tables and materialized views (separate tablespaces for different table partitions)
- Indexes (local/global, b-tree/bitmap)
- C++ binding: OCCi client library (use **SQL bind variables** and **bulk operations**)



Each run contains two 'partial runs' (two event builders were used to process the events from each run)  
 A partial run is the simplest self contained set of spills and events (one partial run per input/output file)

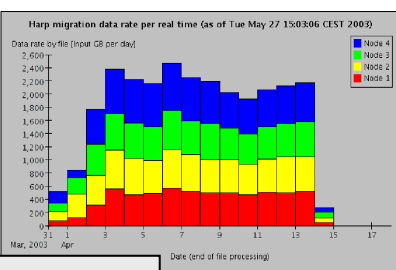
Phase 2: Migration of event collection metadata

Phase 1: Migration of raw event data and metadata

### DATA VOLUMES FOR EVENT DATA

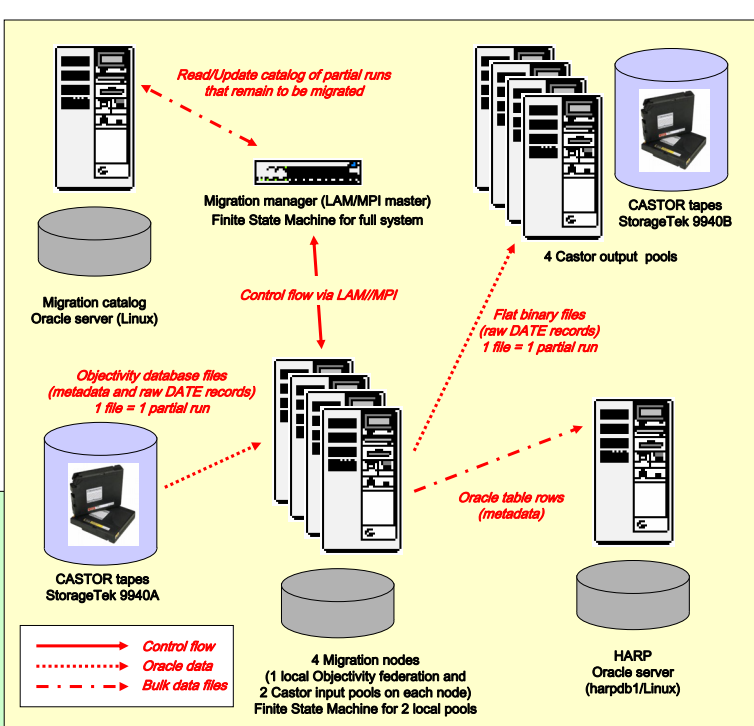
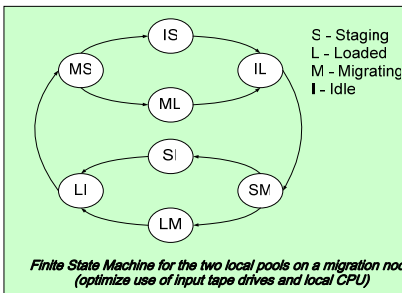
- 30 TB raw data on CASTOR tapes
- 30k partial runs and files (~20k runs)
- 800M events (rows in Oracle event table)
- 100 GB event metadata in Oracle
- In addition: 100 GB Oracle indexes

The idea of storing also the DATE binary records as BLOBs in the Oracle database had been initially considered... but what would you gain? The content of the raw records is not meant to be queried using SQL anyway!



### PHASE 1: RAW EVENT DATA

- Data migrated: **30 TB raw data in 15 days**
- Reuse tools and hardware from previous COMPASS migration (300 TB raw data)
- HARP specific preparation, cleanup and consistency checks: 2-3 months



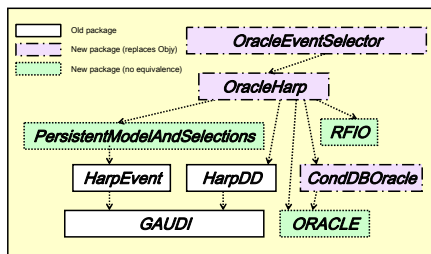
### PHASE 2: EVENT COLLECTION METADATA

- Data volume: < 1 GB
- Complex data model: ~ 4-5 months
- Relational schema design (see diagram)
- Migration application for event collections also checks for internal consistency when 'merging' two partial runs
- Implementation of read-only navigation and selection criteria (performance optimization by the use of bind variables, result set caching and materialized views)
- Re-engineer event selection (move most algorithms to technology-independent PersistentModelAndSelections, tested also in adapted version of Objectivity code)
- Detailed comparison of Oracle and Objectivity results

```

jobOptions.txt
OracleEventManager.EventRange = "124 245";
OracleEventManager.EventTimeRange = "0 997000000";
OracleEventManager.EventAttributes = "0 1 2";
OracleEventManager.DetectorsInEvent = "11 12 13";
  
```

This is translated into an SQL query  
 ... WHERE (124 <= EVENT\_ID AND EVENT\_ID <= 245) AND ...  
 The selection is done on the Oracle server (via a b-tree index) rather than by a full scan with C++ event-by-event check as in Objectivity



```

IEventSelection
string describeEventSelection ()
bool applySelection ( IEventHeader header )
  
```

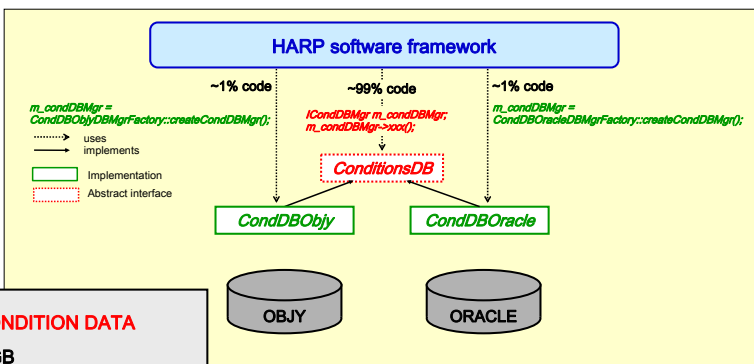
```

OracleEventHeaderFactory
void startLoop ( IEventSelection selection )
OracleEventHeader* createOracleEventHeader ()
  
```

This instantiates a transient C++ 'header' from the Oracle table row that is currently cached in C++ memory as a result of the SQL query

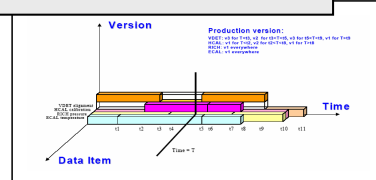
### PHASE 3: CONDITION DATA

- Data volume: < 10 GB
- Fast and rather painless: ~ 1 month
- No design needed, solution available: use Oracle implementation of the same abstract interface that was implemented in Objectivity
- Data migration: via simple dedicated tools (partly using the API, partly bypassing it)
- Software for read-only data access: only minor changes with respect to Objectivity



### CONDITIONS DATABASE API

- Metadata for condition data: data item name, validity interval [since,till], version
- Actual condition data encoded in binary records (BLOBs): strings (calibration file names), streamed vectors of numbers (beam or detector control parameters)



### SUMMARY

- Large data migration successfully completed!
- Hybrid data store with Oracle metadata navigation
- Data migrations may also be needed at LHC!

### Many thanks to:

IT-DB, IT-DS, IT-ADC,  
 Castor team, S. Giani,  
 I.Papadopoulos