

LHCb Computing Model

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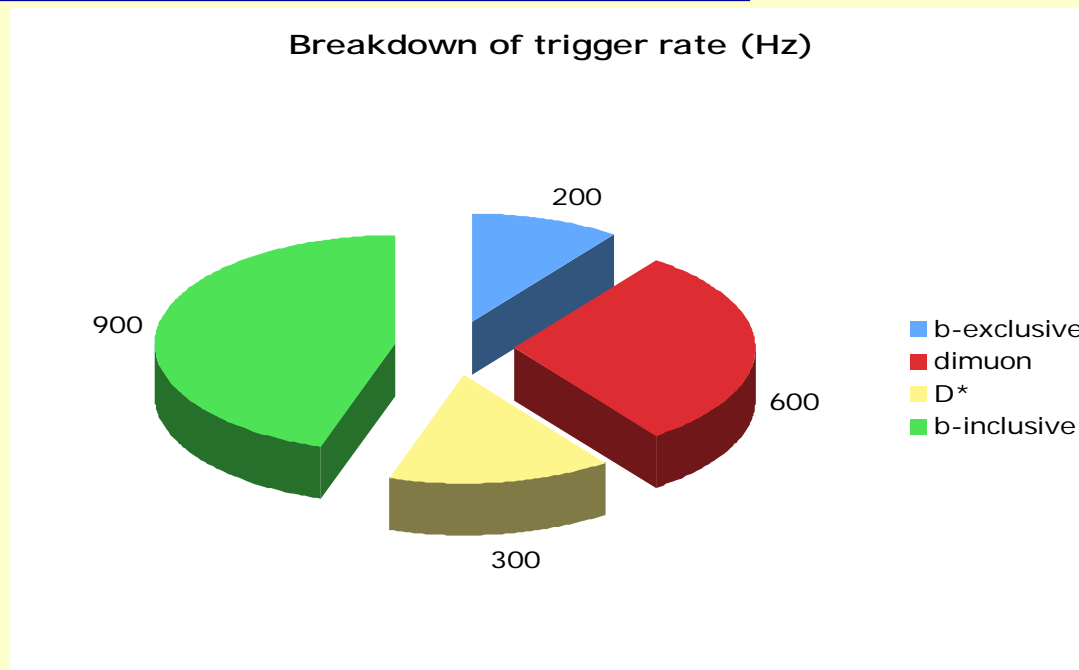


Colloque LCG-France, 14 Decembre 2005, Lyon

Outline

- ◆ Data and Data Flow
- ◆ Computing Model
- ◆ Computing resource needed
- ◆ LCG grid usage in SC3

Input data: Online



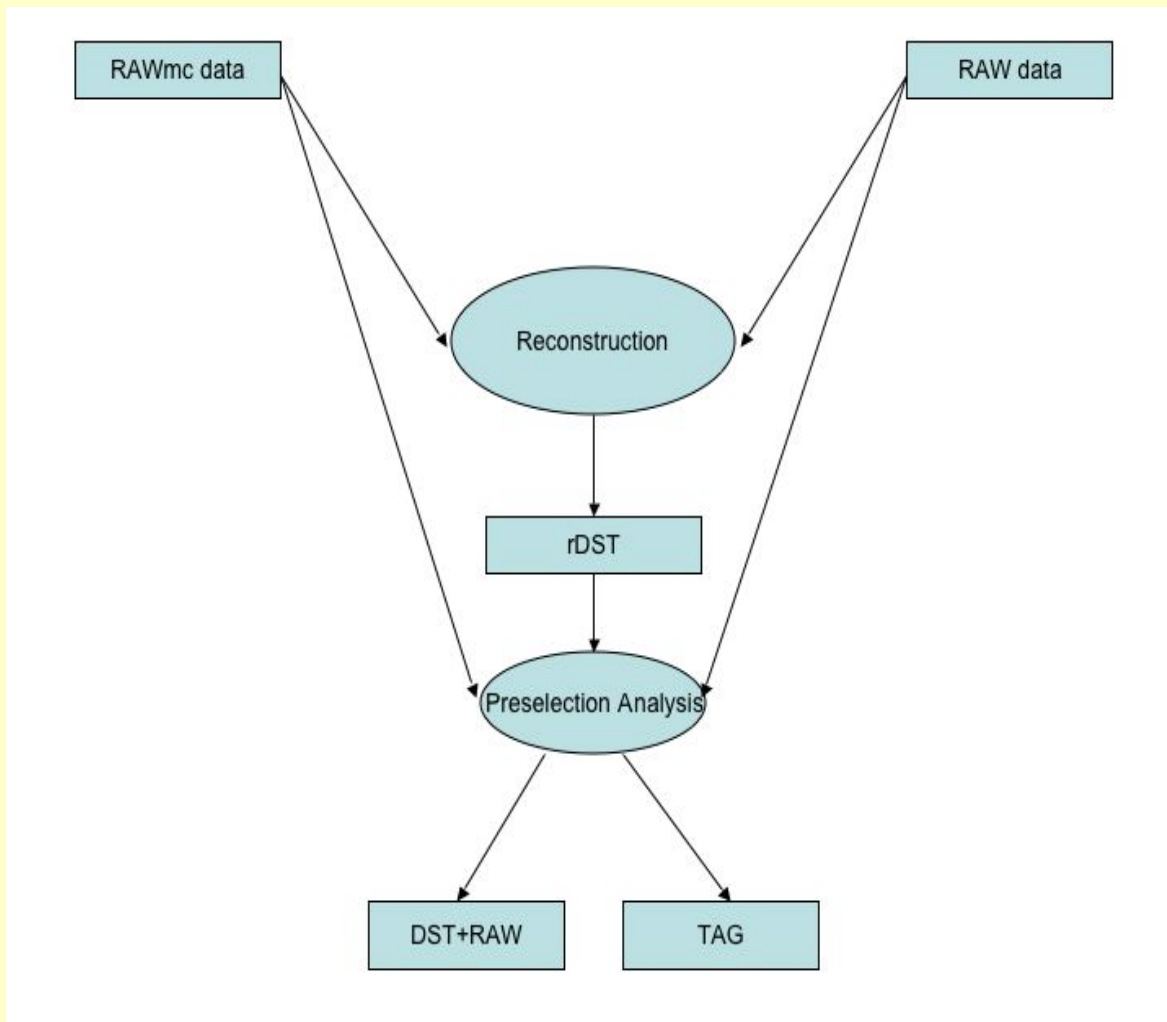
- ◆ 2 streams sent to computing center
 - ✦ 200 Hz reconstructed B-exclusive
 - ✦ 2000 Hz RAW data including B-exclusive
- ◆ 500 TB of RAW data produced annually
 - ✦ 2×10^{10} events, 25KB/event

Input data: Simulation

- ◆ Simulated data hits produced with GEANT4-based application (**Gauss** application).
- ◆ Hits digitised & spillover added (**Boole** application)
- ◆ Format of simulated data is similar to those from DAQ
 - ✦ additional history information also stored
- ◆ 160 TB of DST data annually
 - ✦ 4×10^8 events, 400KB/event

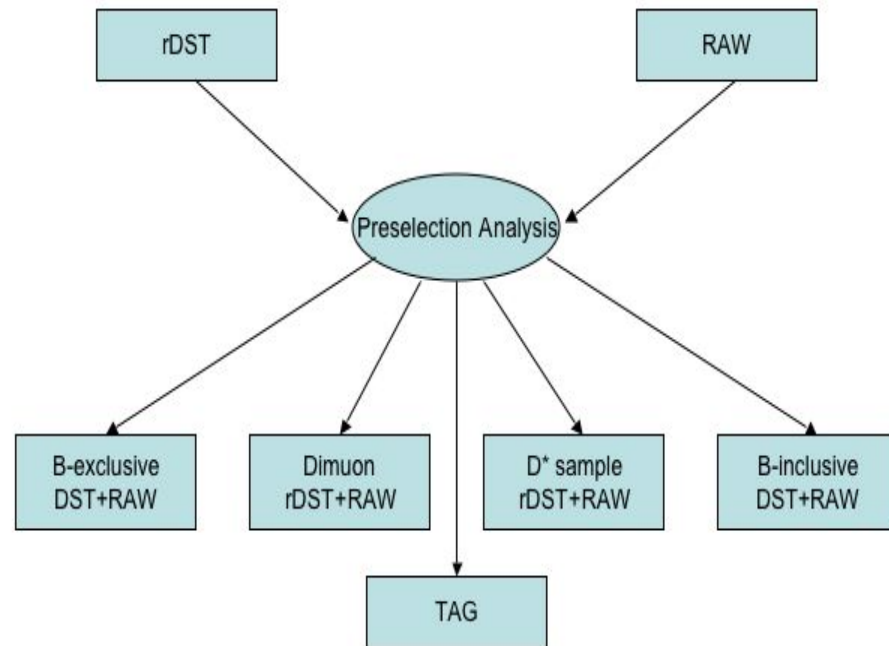
Dataflow: Reconstruction

- ◆ RAW data is reconstructed, e.g.
 - ✦ Calo. Energy clusters
 - ✦ Particle ID
 - ✦ Track momentum
 - ✦ ...
- ◆ At recons time only enough info is stored to allow physics pre-selection to run at a later stage - reduced DST (rDST)



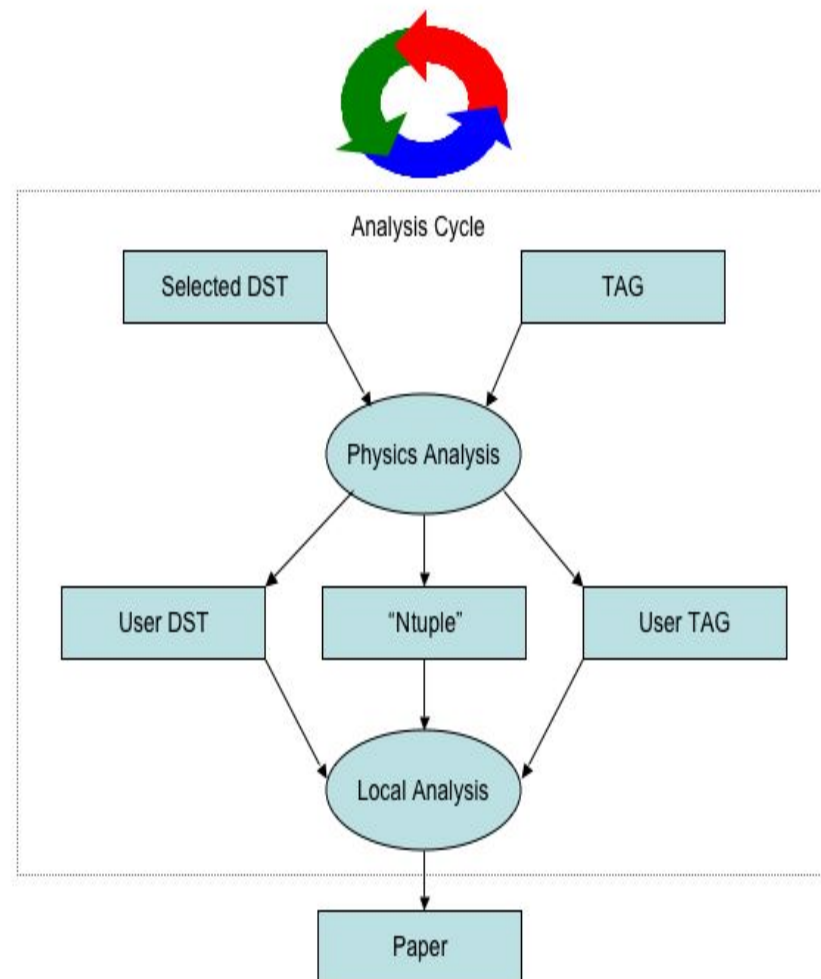
Dataflow: Preselection (Stripping)

- ◆ rDST is analysed in production-mode
 - ✦ event streams for further analysis;
 - ✦ Preselection Algorithms use as input rDST & RAW
- ◆ Event to be output will have additional reconstructed info added:
 - ✦ (full) DST+ RAW data
- ◆ Event Tag Collection - created to allow “quick” access to data; contain “metadata”

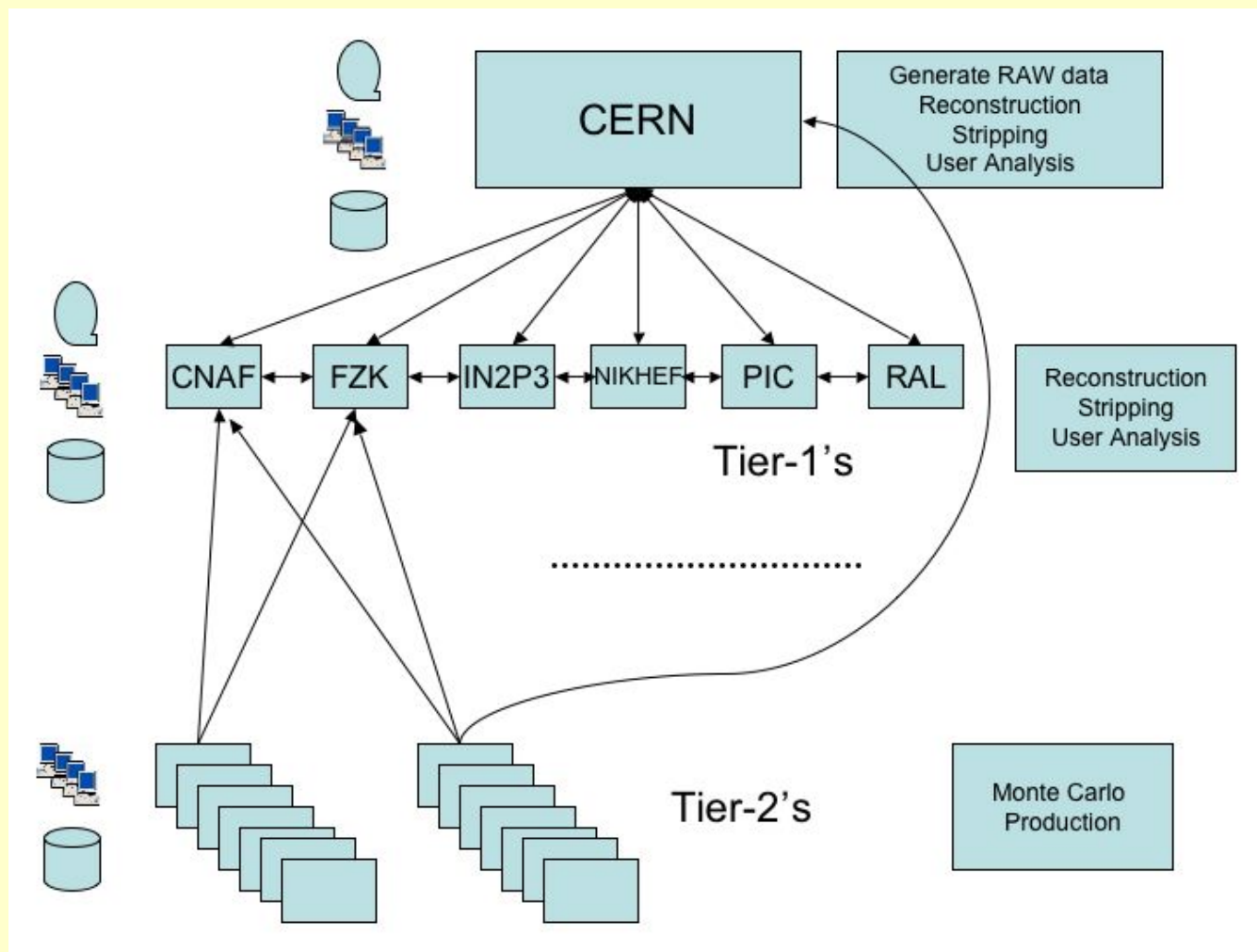


Dataflow: Analysis

- ◆ User physics analysis will be primarily performed on the output of the stripping
- ◆ Analysis generates quasi-private data e.g. Ntuple and/or personal DSTs
- ◆ Data publicly accessible - enable remote collaboration



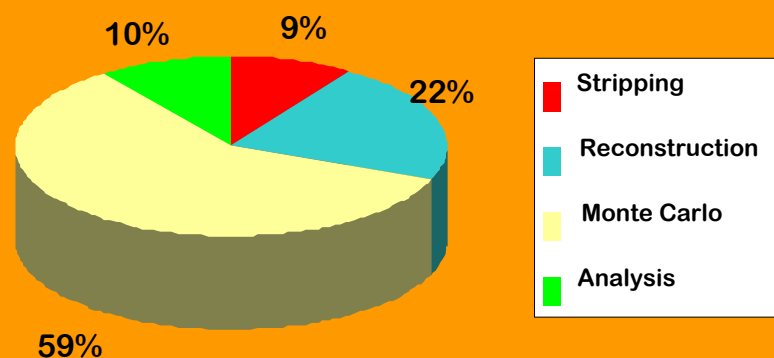
LHCb Computing Model



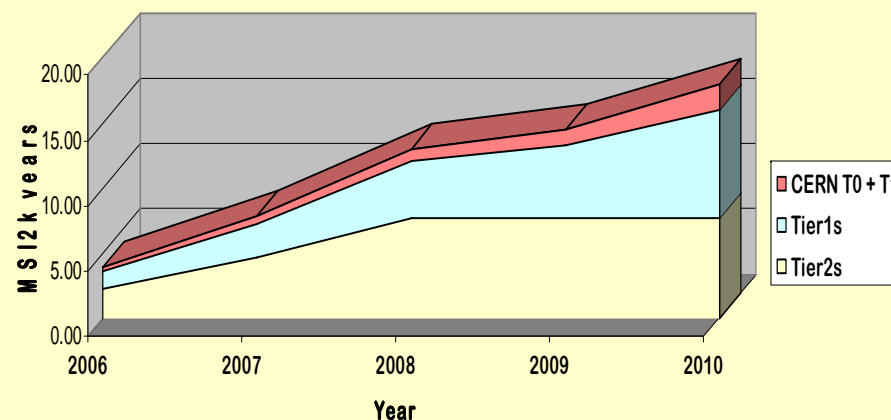
Computing resources: CPU

MSi2k*year	2006	2007	2008	2009	2010
CERN T0 + T1	0.27	0.54	0.90	1.25	1.88
Tier1s	1.33	2.65	4.42	5.55	8.35
Tier2s	2.29	4.59	7.65	7.65	7.65
Total	3.89	7.78	12.97	14.45	17.87

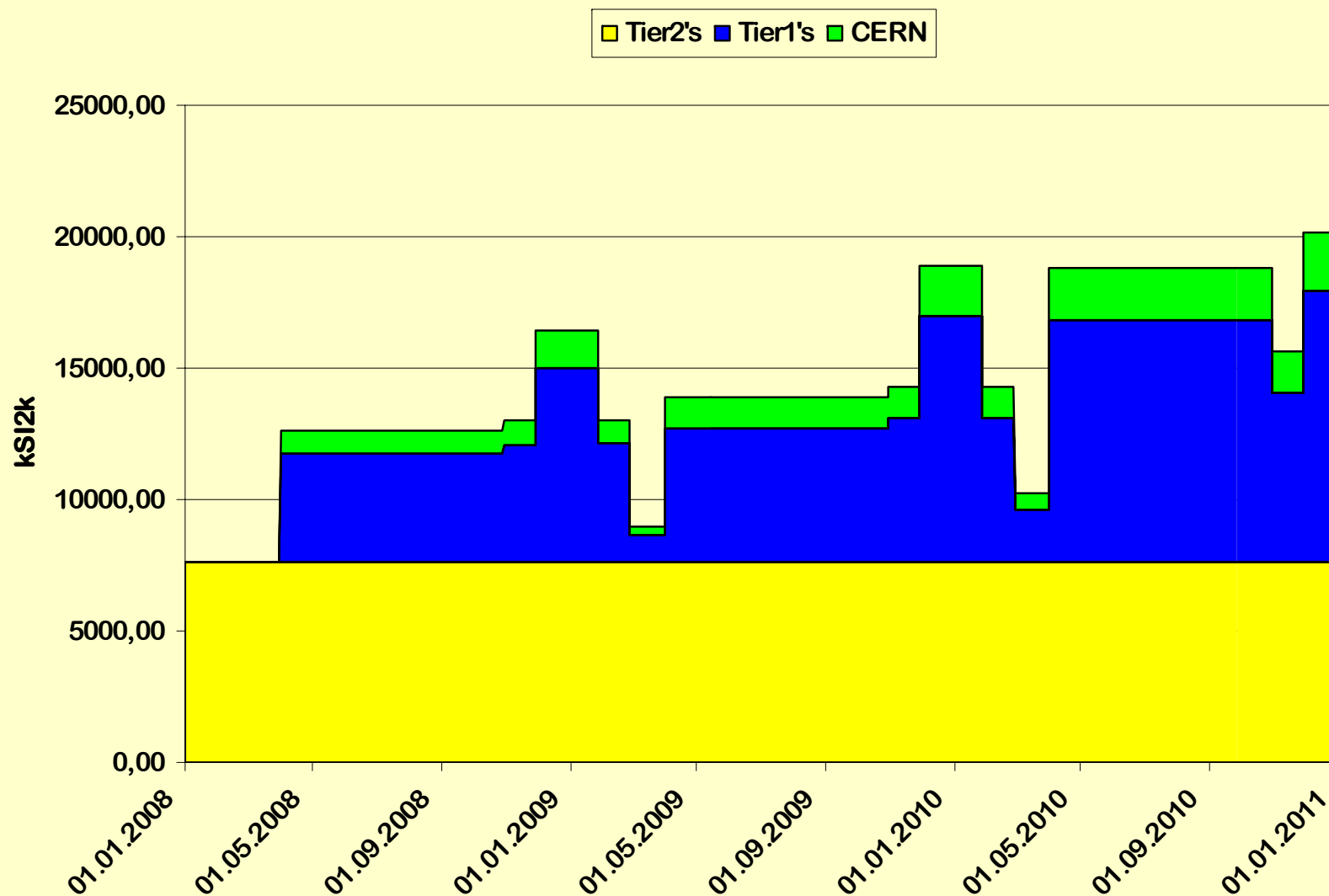
Breakdown of CPU needs by activity in 2008



CPU need profile



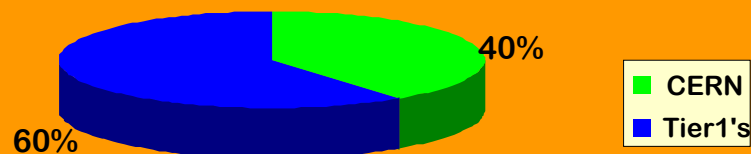
CPU Power profile



Mass Storage

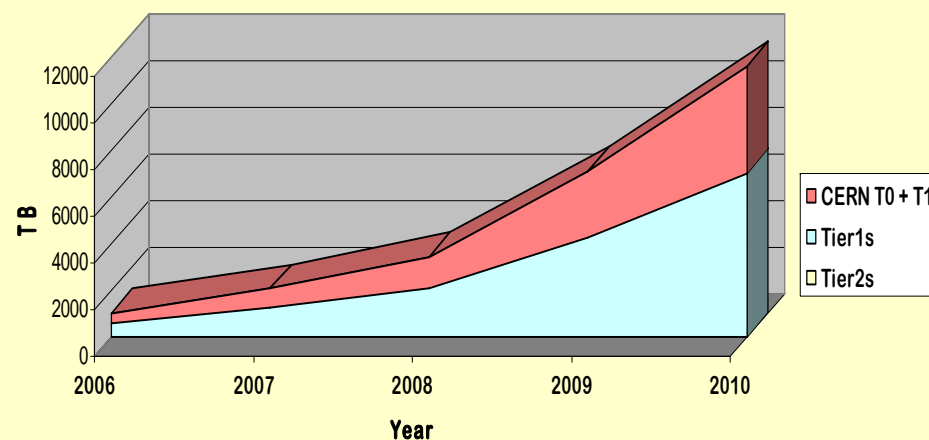
(TB)	2006	2007	2008	2009	2010
CERN T0 + T1	408	816	1359	2858	4566
Tier1s	622	1244	2074	4286	7066
Tier2s					
Total	1030	2060	3433	7144	11632

Breakdown of MSS needs in 2008



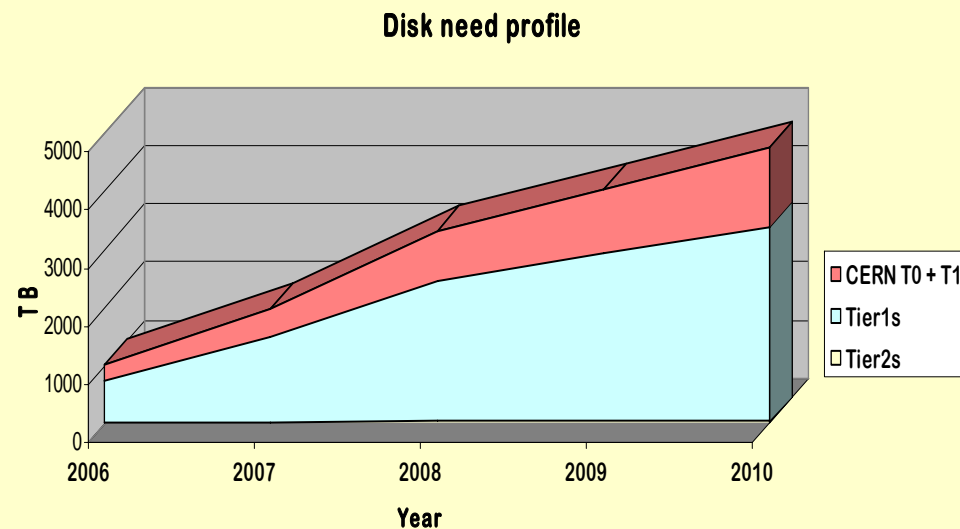
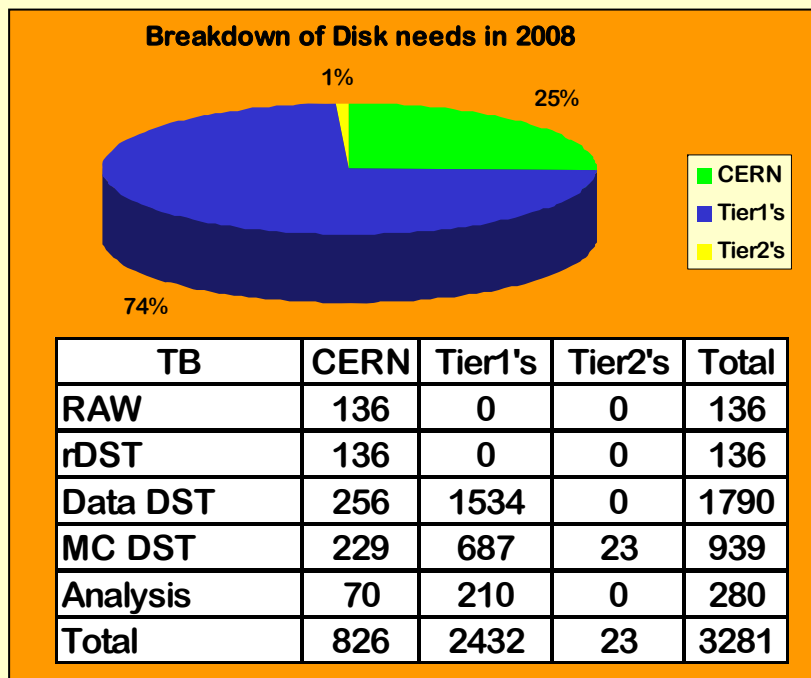
TB	CERN	Tier1's	Total
RAW	500	500	1000
rDST	143	857	1000
Data DST	556	556	1112
MC DST	160	160	321
Total	1359	2074	3433

MSS need profile



Disk Storage

(TB)	2006	2007	2008	2009	2010
CERN T0 + T1	248	496	826	1095	1363
Tier1s	730	1459	2432	2897	3363
Tier2s	7	14	23	23	23
Total	984	1969	3281	4015	4749



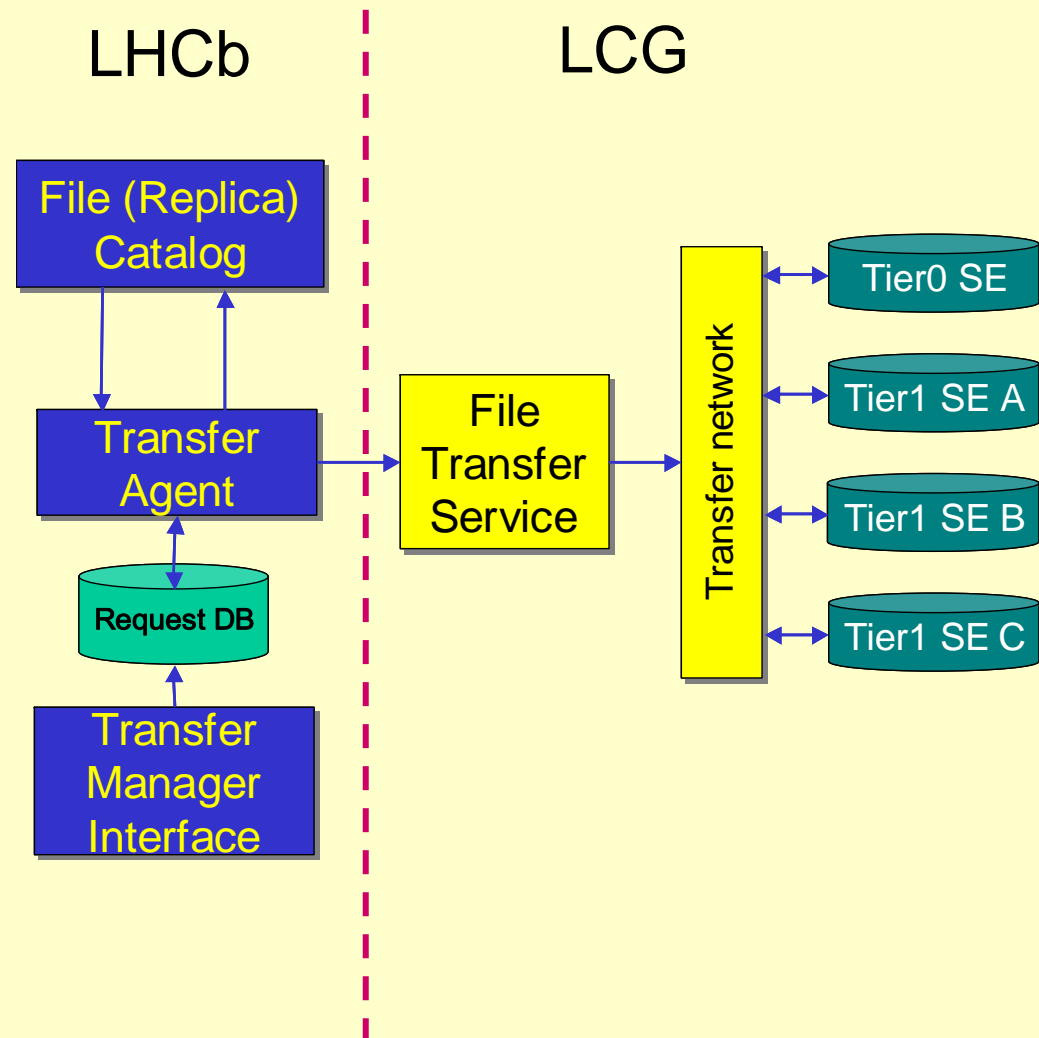
LHCb Data and Service Challenges

SC3 Phase 1: goals

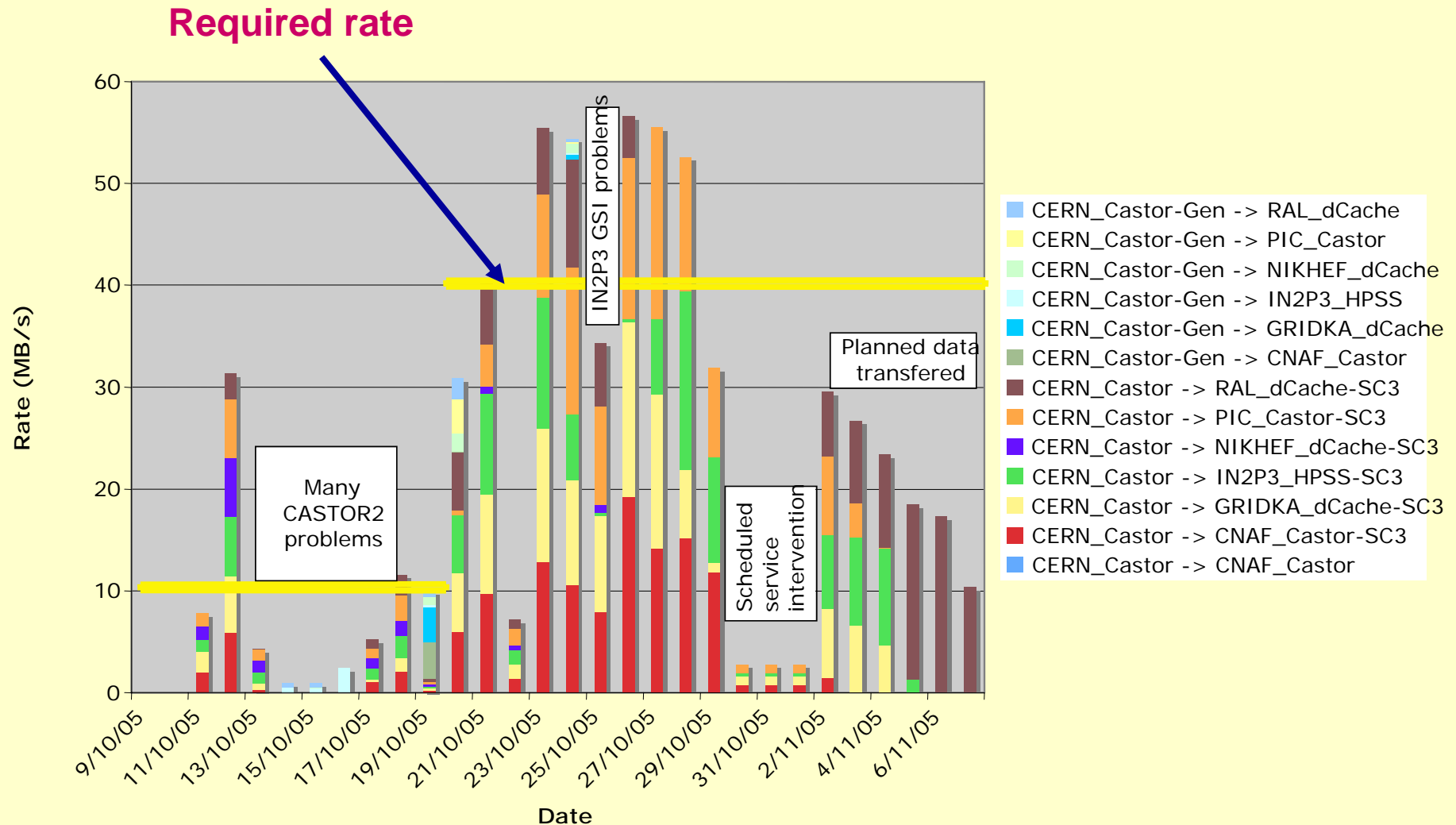
- ◆ Demonstrate Data Management tools to meet the requirements of the Computing Model
 - ✦ Data transfers from Tier0 CERN center to the Tier1 centers
 - ✦ Massive file removal
 - ✦ Data transfers between the Tier1 centers
 - ✦ ~30% of the needs at the LHC start
- ◆ Metrics
 - ✦ a) CERN 6TB/week out, Tier1s 1TB/week in
 - ✦ b) CERN 24TB/week out, Tier1s 4TB/week in
 - ✦ c) All sites 2TB/week out, 12TB/week in
 - ✦ d) Remove 50k in 24 hours

SC3 Phase 1: Data Transfer tools

- ◆ Central Data Movement model based at CERN.
 - ✦ FTS+TransferAgent+RequestDB
- ◆ TransferAgent+ReqDB developed for this purpose.
- ◆ Transfer Agent run on LHCb managed lxgate class machine



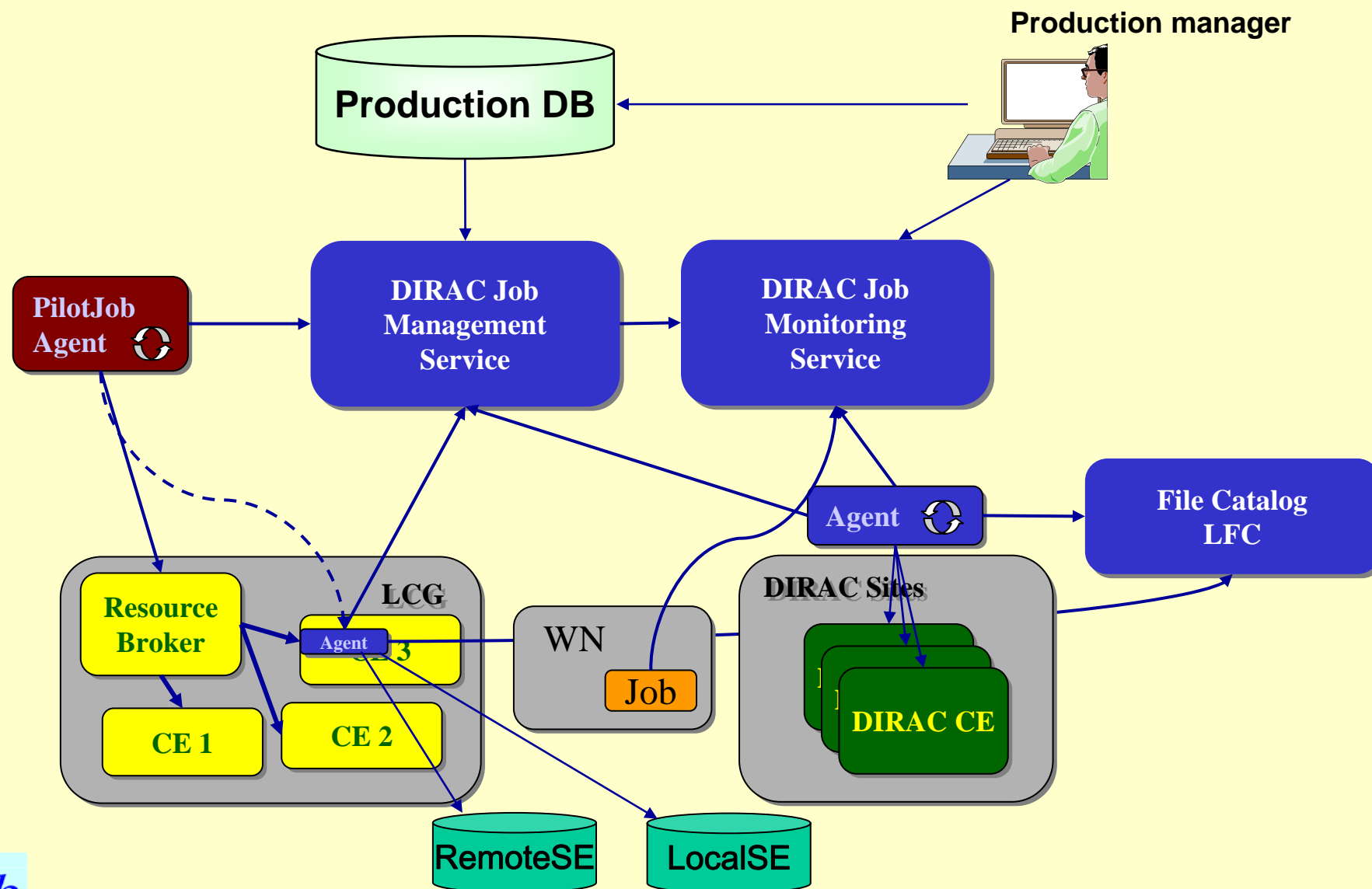
SC3 Phase 1: Data Transfer results



SC3 Phase 2 tasks

- ◆ Demonstrate the full data processing sequence in real time
- ◆ Demonstrate full integration of the Data and Workload Management subsystems
- ◆ Demonstrate the distributed analysis in T1 centers on the grid

Data production on the grid

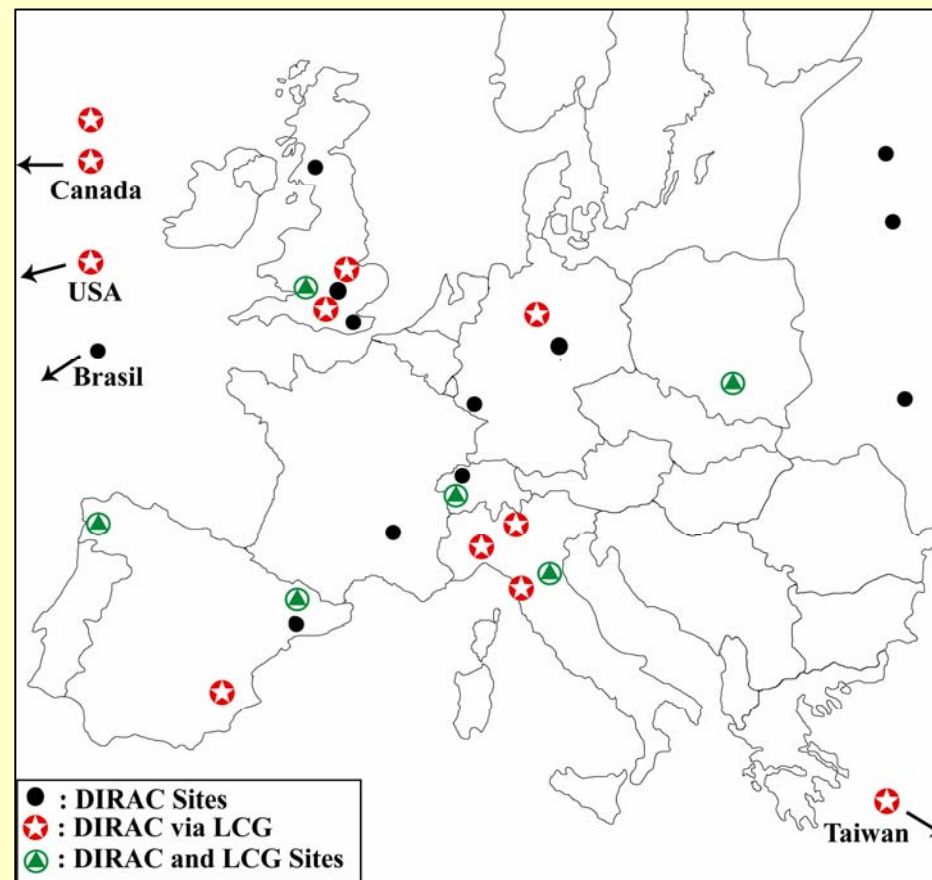


DIRAC overlay network

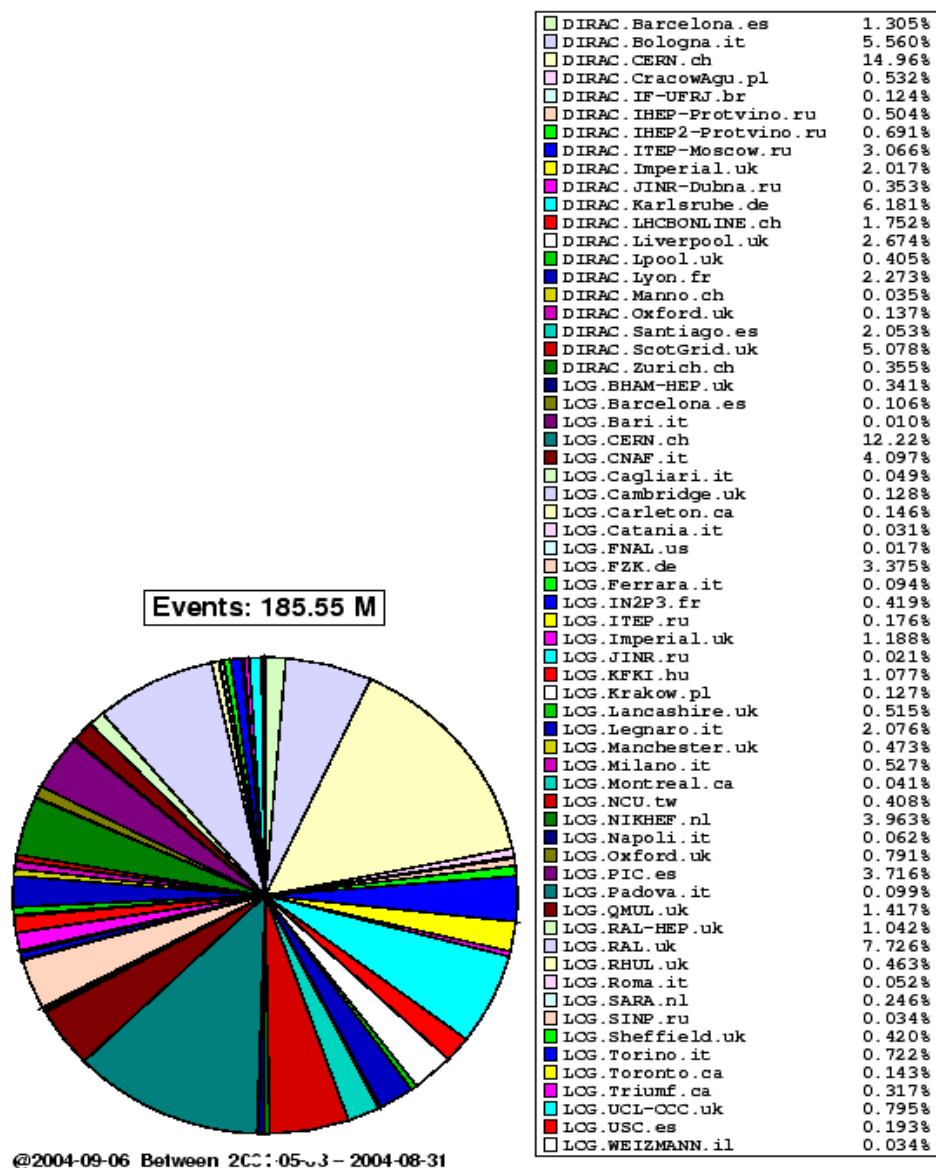
- ◆ Community Overlay Grid System (COGS) paradigm
- ◆ The COGS paradigm is first of all there to abstract heterogeneous resources and present them as single pool to a user :
 - ✦ LCG or DIRAC sites or individual PC's
 - ✦ Single central Task Queue is foreseen both for production and user analysis jobs
- ◆ The overlay network is dynamically established
 - ✦ No user workload is sent until the verified LHCb environment is in place

DC04 results

- ◆ Effectively saturated LCG and all available computing resources during the 2004 Data Challenge
- ◆ Supported up to **5500 simultaneous jobs** across **>60 sites**
- ◆ Produced, transferred, and replicated **80 TB** of data, plus meta-data
- ◆ Consumed over **425 CPU years** during last 4 months
- ◆ ~200K jobs
- ◆ ~95% success rate DIRAC
 - ✦ ~60% success LCG



DC04 results (2)

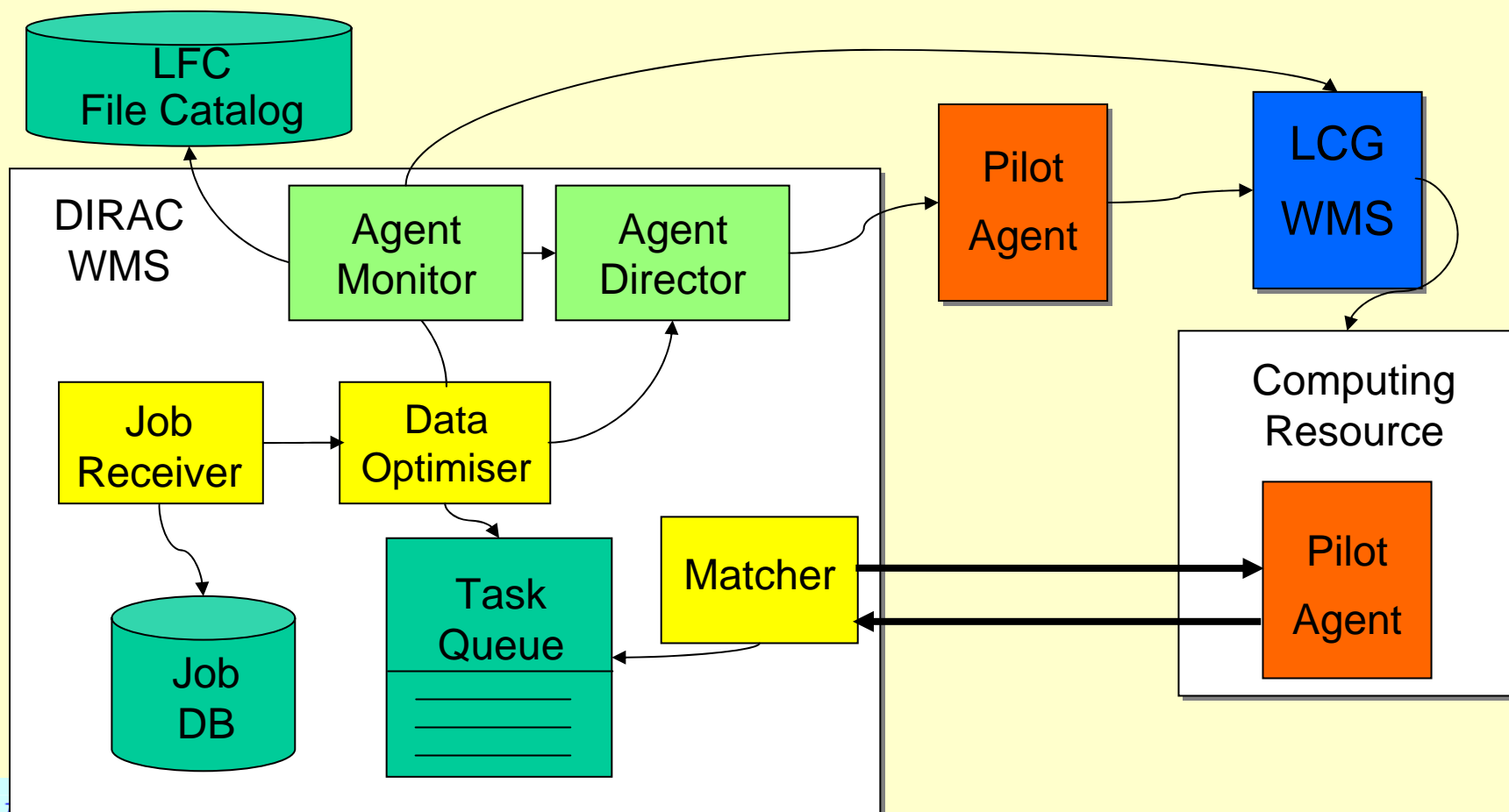


20 DIRAC Sites

43 LCG Sites

Distributed analysis

- ◆ The same COGS paradigm is applied now for the Distributed User Analysis on the grid



Conclusions

- ◆ LHCb Computing needs are similar to other LHC experiments
 - ✦ 2 PB/year (RAW + MC + Reconstruction)
- ◆ LHCb Computing Model defined in the Computing TDR fixes a hierarchy of the Tier centers with well defined functions
- ◆ Service Challenge showed that desired data transfer rates can be achieved but further system improvements are needed
- ◆ LHCb production system (DIRAC) is successful in making intensive use of the LCG grid. It is now being extended for the Distributed User Analysis.

Back-up slides

Summary

- ◆ CPU needs dominated by simulation needs
- ◆ Reconstruction performed of current year's data performed twice
 - ✦ quasi-real time
 - ✦ 2 month period after data taking
- ◆ Production analysis (stripping) to create base analysis sets performed 4 times a year
 - ✦ Twice associated with reconstruction
 - ✦ Twice in a 1-month period

Produced data in 2008 (TB)	RAW	rDST	Stripped	Simulation	Analysis
	500	500	556	160	200

CPU needs in 2008 (MSI2k.yr) (incl efficiency factors)	Recons.	Stripping	Simulation	Analysis
	3.56	1.36	7.65	1.29