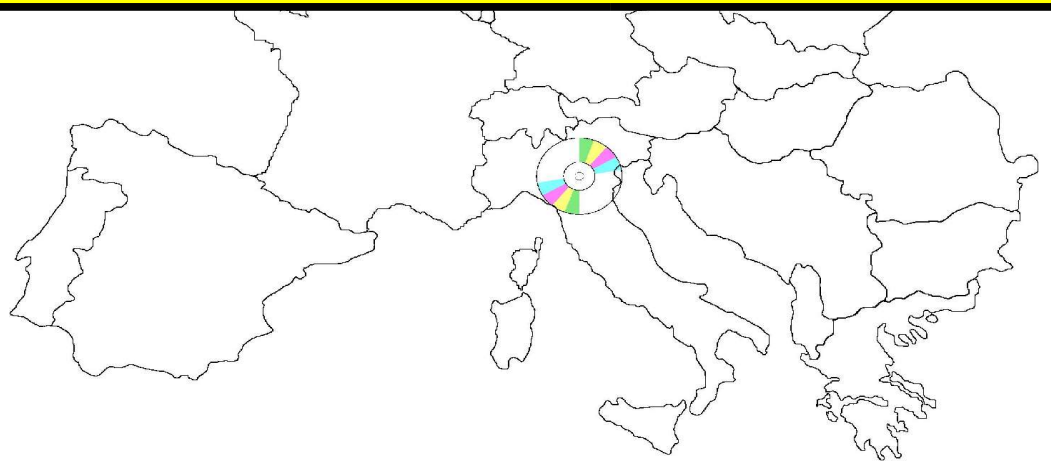
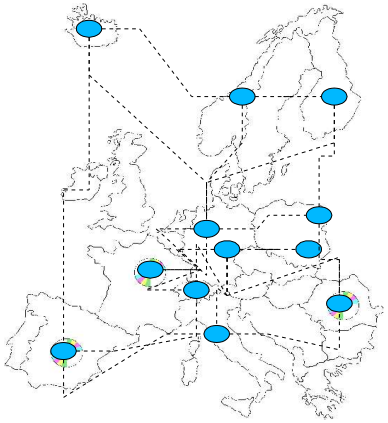
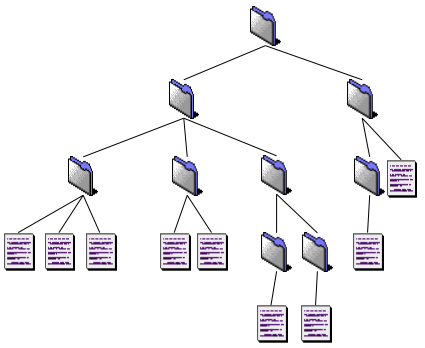


# Distributed Analysis with AliEn & ROOT







Andreas Peters and Fons Rademakers

ALICE Collaboration



# Overview

**Introduction**

**I** AliEn System as a GRID Framework

- **Some Design Features**
- **Performance Tests**

**II** Batch Analysis with AliEn & ROOT

- **Task Splitting in AliEn**
- **Result Merging**

**III** Interactive Analysis with AliEn & PROOF

- **Multi-cluster PROOF Environment**
  - PROOF in a distributed environment
  - Packetizing for multi-cluster PROOF
  - Interactive Job Reservation in AliEn



# Introduction

How can we analyze data in the future?

- LHC era experiments will produce data in the order of PB/y

- Conventional Mass Storage System and Batch Queue System of individual computing centers can handle very well subsets of this dataset.

- The scale change requires an equivalent scale change from single computing centers to a GRID of computing centers

- Efficient Analysis of large datasets requires:
  - ➔ Indexing and pre-selection of data using meta data tags
  - ➔ Highly parallel processing with efficient data distribution



# Introduction

A step towards a solution: (Ali) ROOT + AliEn

- **ROOT** is becoming most popular available physics analysis toolkit.
  - Interactive analysis work in familiar C++ style syntax
  - Data visualization, an object-oriented I/O system
  - Crucial role for the LCG project (POOL) ?!
  - Is successfully used within the AliROOT framework of the ALICE experiment as an all in one solution
- **PROOF** extends workstation based concept of ROOT to
  - Parallel processing on a cluster
  - User procedures are kept identical during an analysis session
  - Tasks are distributed automatically in the background
- **AliEn** as a GRID analysis platform provides two key elements:
  - A global file system
    - ➔ files are indexed and tagged in a virtual file catalogue and everywhere globally accessible
  - A global queue system
    - ➔ global job scheduling according to resource requirements



# What is **AliEn**?



# AliEn System as a GRID Framework

- **AliEn** = ALICE Environment
  - AliEn originally designed as a distributed computing and file storage facility for the ALICE experiment
- Under **development since 2001** by:
  - Small team of the ALICE Offline Group (2-4 FTE)
  - Temporary people like fellows and summer students etc.
- **Implementation** of main components
  - PERL - Web Service (using SOAP::Lite)
  - C/C++ - API, File Transfer Layer, Globus/GSI
- **Open Source Components**:
  - SOAPlite, gSOAP, MySQL, OpenSSL, OpenLDAP, Apache ...

  → only a small part of the code had to be developed in house



# Basic Guidelines and Concepts

- ✗ **Modularity**
  - ✓ Service Plugin Architecture
  - ✓ SOAP Communication Bus
- ✗ **Scalability**
  - ✓ Distributed Databases
  - ✓ Distributed Core Services
- ✗ **User Identity**
  - ✓ Concept of “user” + permissions
  - ✓ Concept of user assigned resources
- ✗ **Virtual Organisations (VO)**
- ✗ **Interoperability**
  - ✓ **G**rid**2G**rid Interfaces
- ✗ **File/Queue System Similarity**
- ✗ **Central Configuration/VO configuration**
- ✓ **Security**



# Some Design Features of AliEn



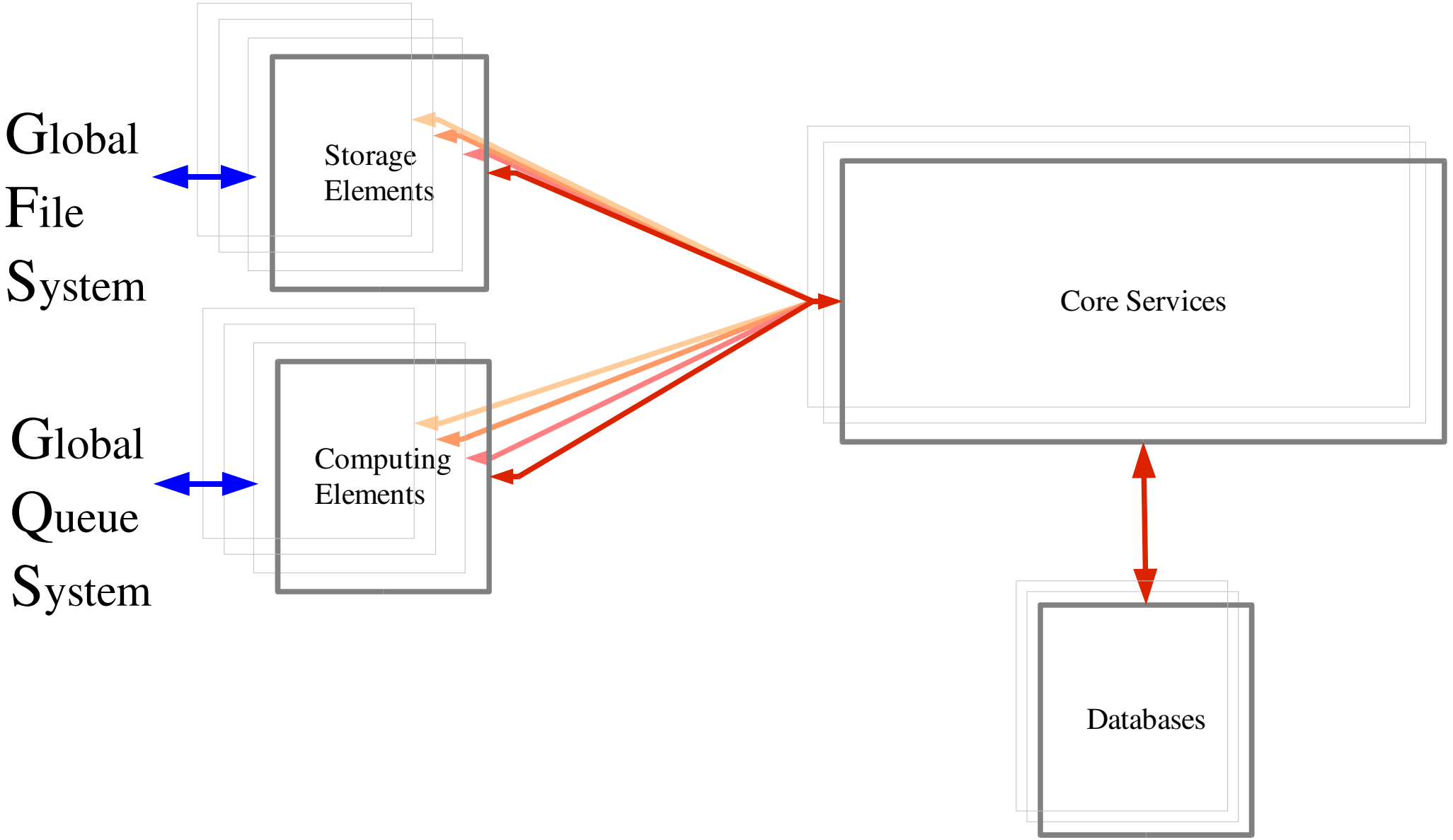
# AliEn System as a GRID Framework

## -Virtual Grid Components-

- Global Queue System
  - Batch Job System
  - Interactive Job System
- Global File System
  - File Catalogue
    - Browsing
    - Access
    - Manipulation
    - Replication
  - Meta Data Catalogue

# AliEn System as a GRID Framework

## -Simplified System View-





# AliEn System as a GRID Framework

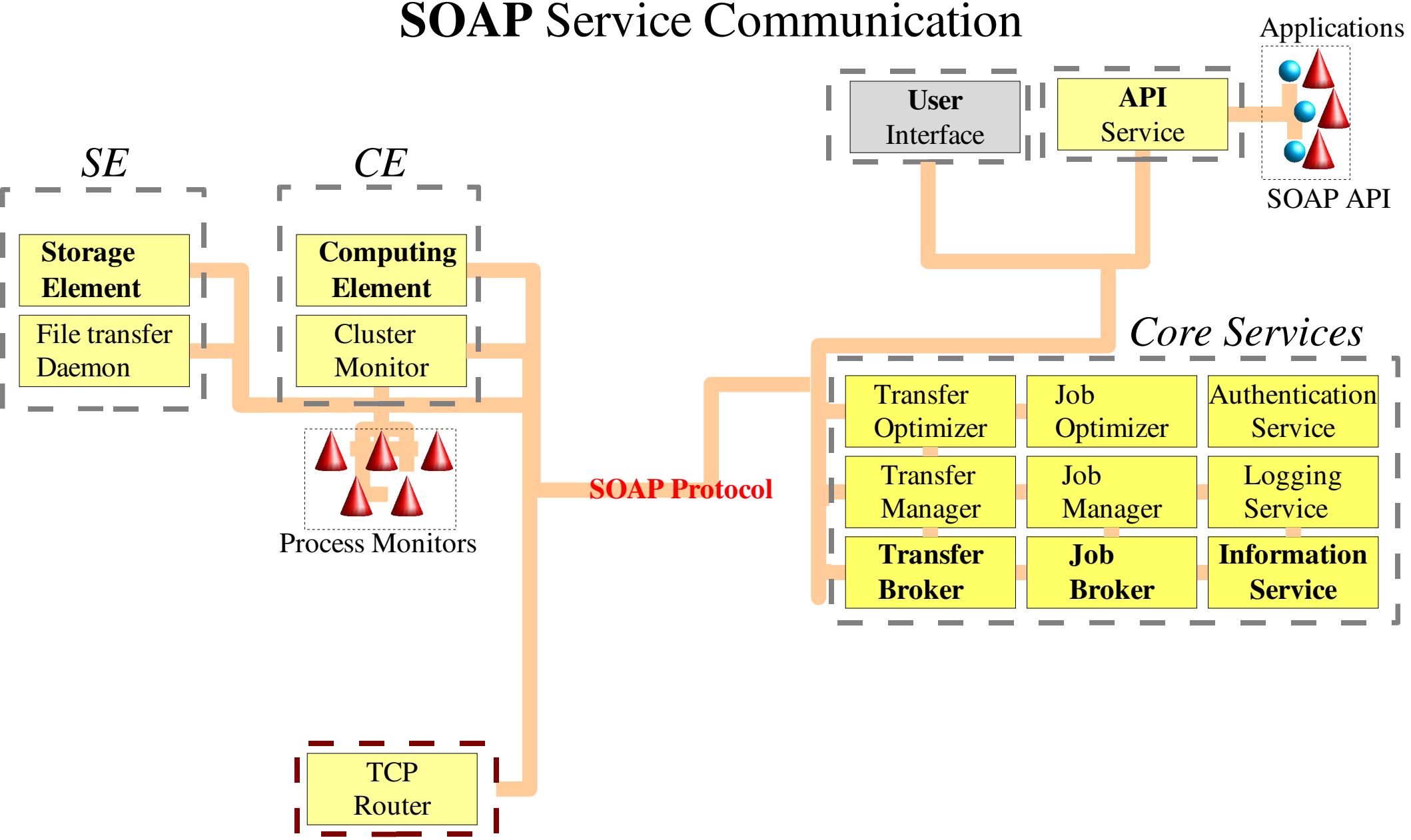
## -Simple Layout-

- How do Components Communicate ?



# AliEn System as a GRID Framework

## SOAP Service Communication





# AliEn System as a GRID Framework

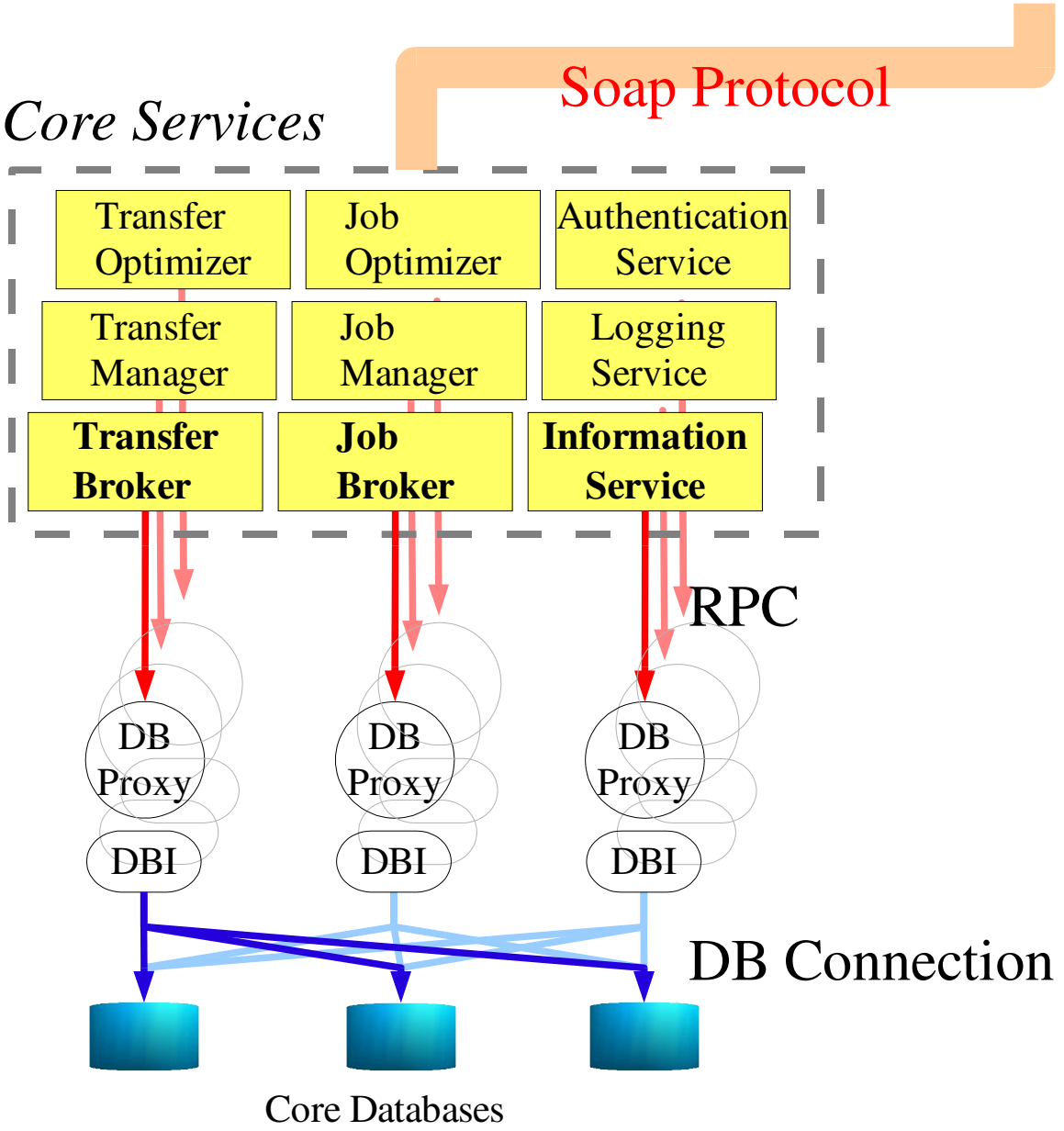
## -Simple Layout-

- How do we provide DB access for various DB engines?
- How do we preserve modularity?

# AliEn System as a GRID Framework

## -Core Services DB Access-

- Core Services talk to Core DBs through DB Proxies via RPC calls
- DB Proxies connect to "any" DB via PERL DBI module
- Core DB information exported to outside world via Core SOAP Services





# AliEn System as a GRID Framework

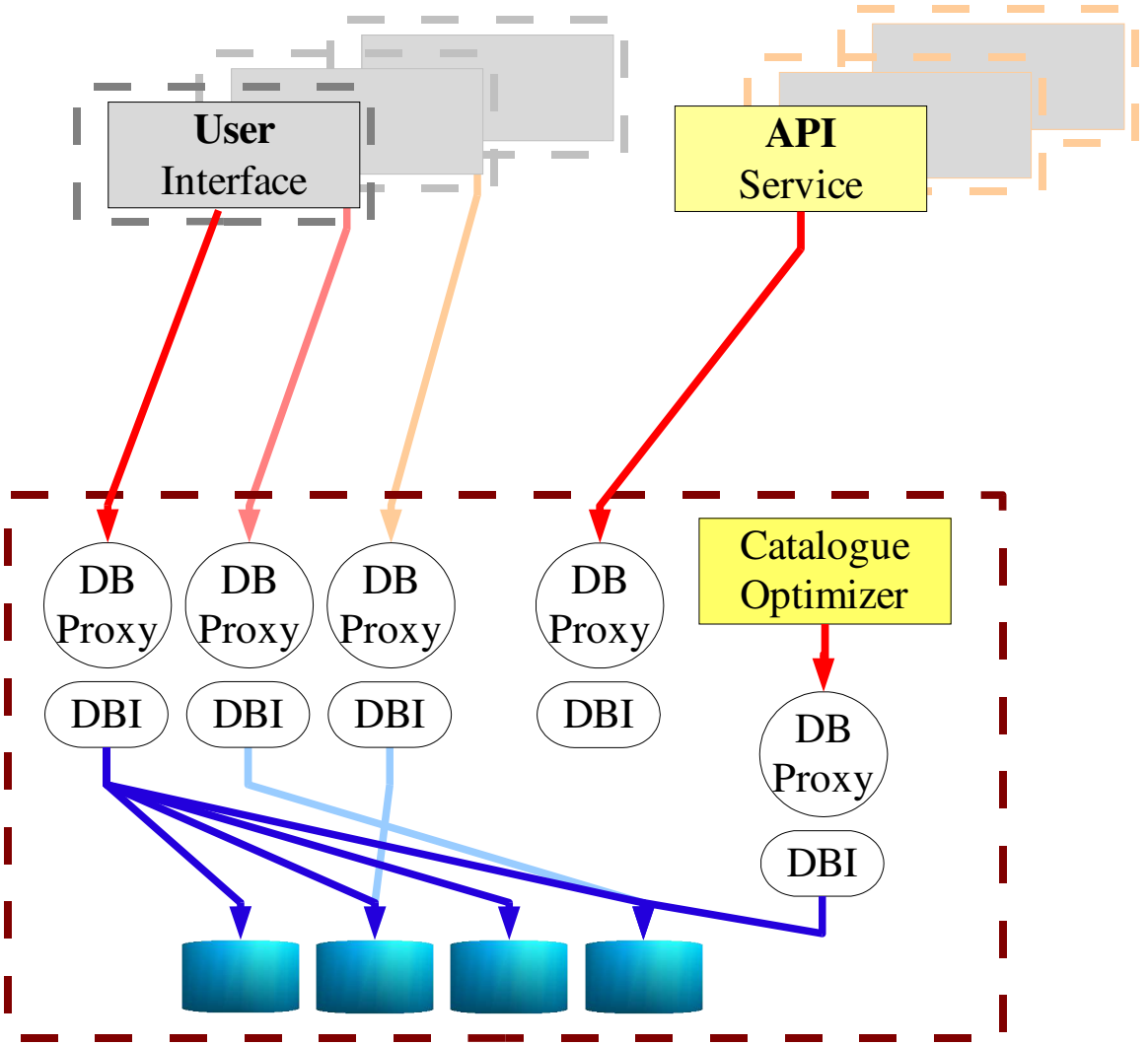
## -Simple Layout-

- How can we design a scalable file catalogue?
- How can we provide global file access?

# AliEn System as a GRID Framework

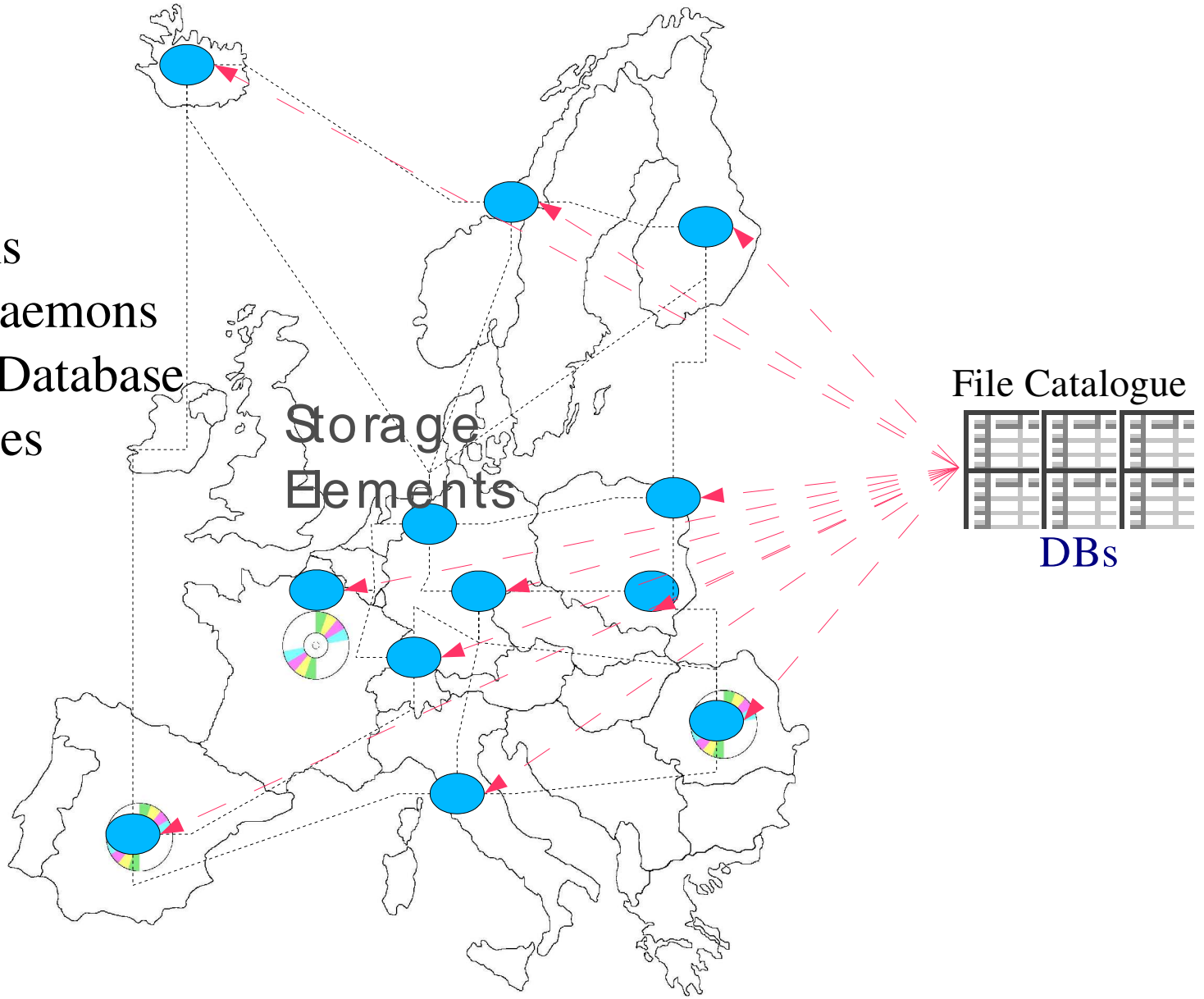
## - File Catalogue Components -

- File Catalogue implemented by "distributed" DBs
- DB Access through DB Proxies
- Dedicated Service for Optimization



# AliEn Filesystem

- Components:
  - Storage Systems
  - File Transfer Daemons
  - File Catalogue Database
  - Transfer Services



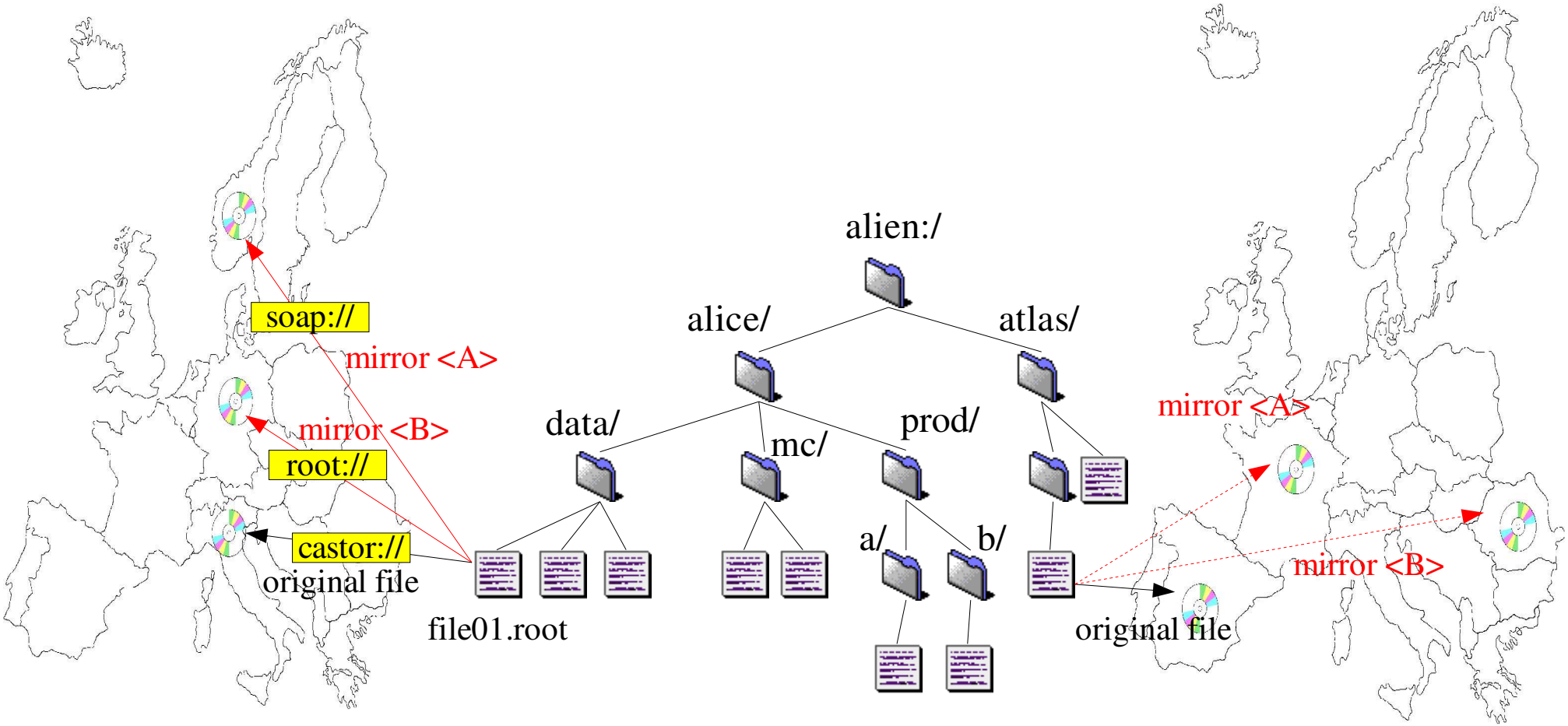

Transfer Optimizer

Transfer Manager

**Transfer Broker**

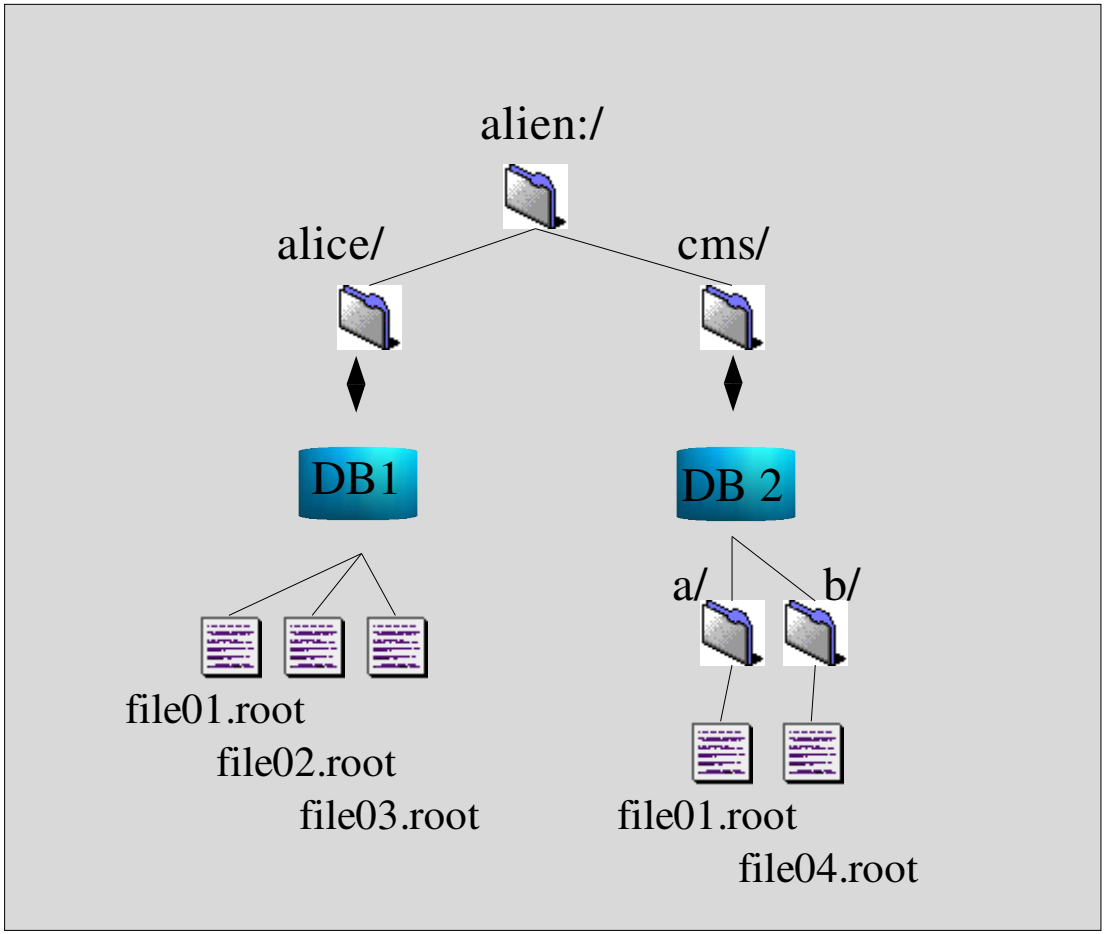
Transfer Queue DB

# Catalogue Hierarchy

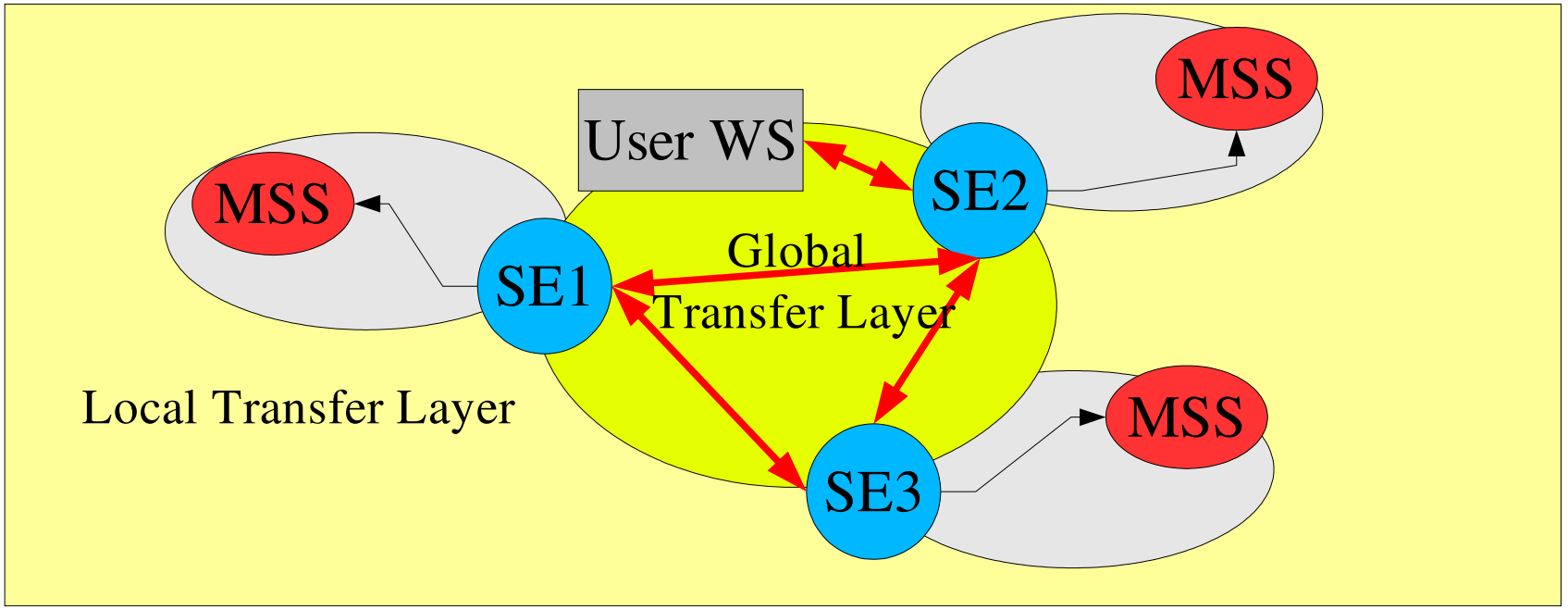



- Catalogue is based on a database tree structure
- Folders are linked database tables
- Files are table entries with location pointers

# Distributed Databases



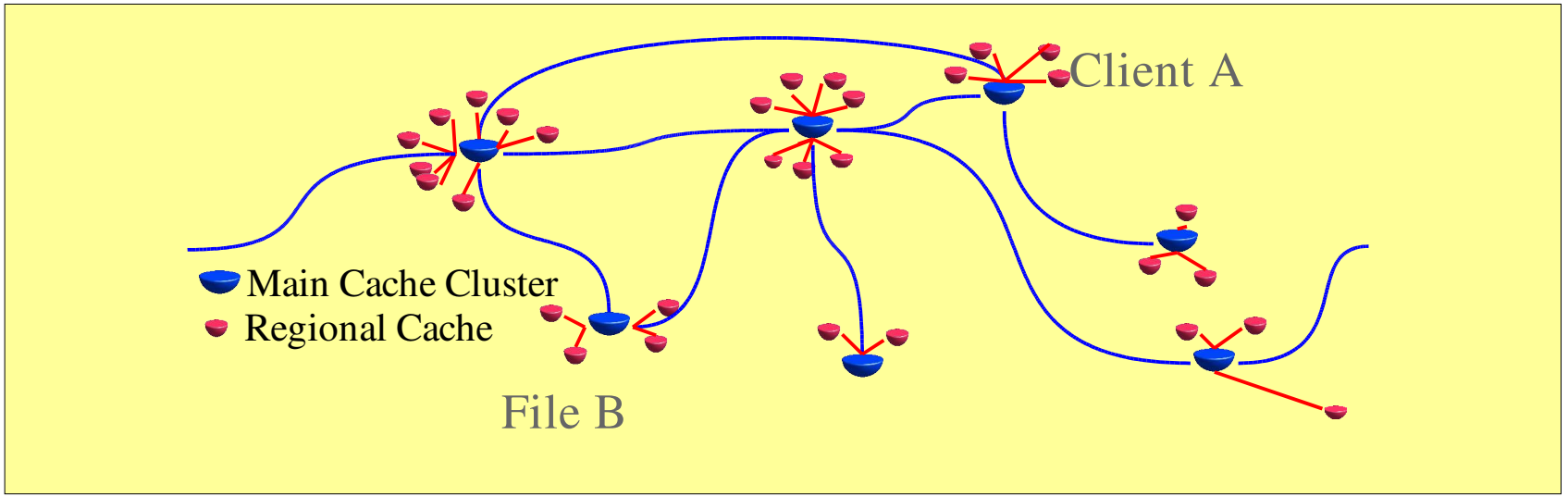
# File Access



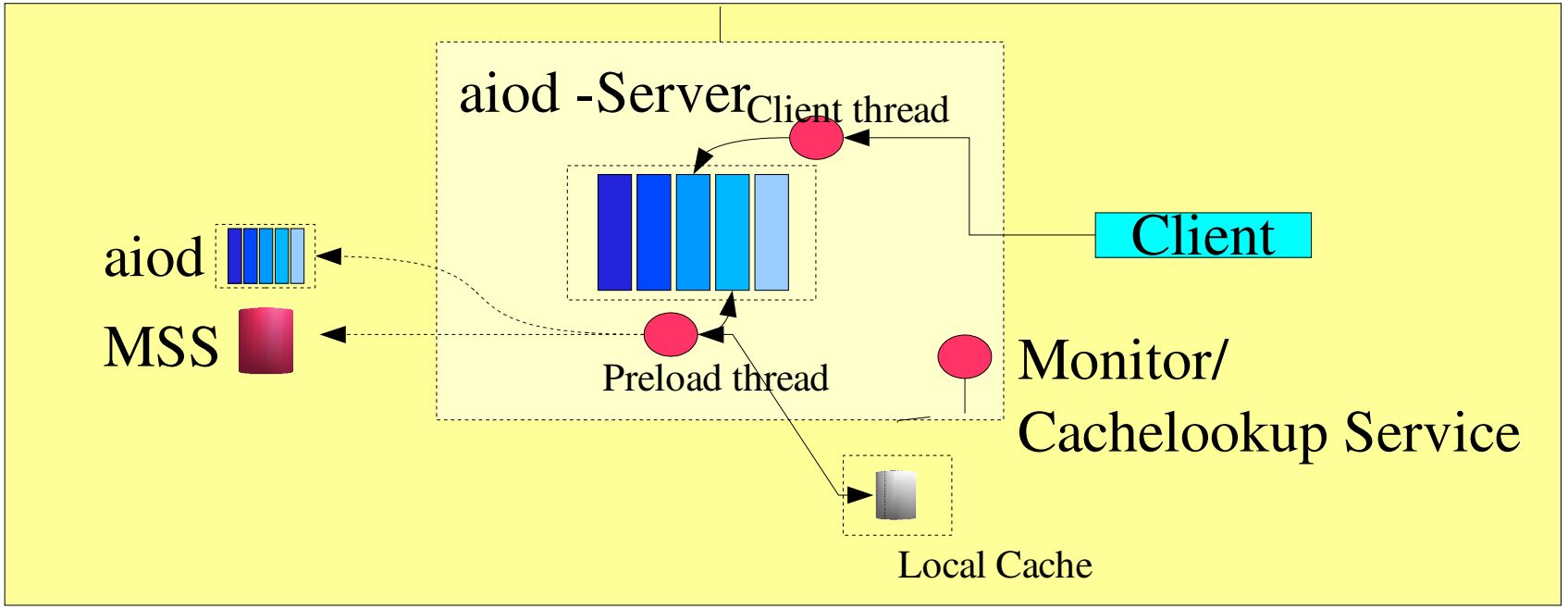

## Global File Transfer Layer in AliEn:

- Scheduled Transfer
  - bbftp
  - gridFTP
  - aiod
- Interactive Access
  - aiod

# Crosslink-Cache-Architecture




# aiod – AliEn I/O Daemon





# AliEn Crosslink-Cache-Architecture

## Implemented Features

- Data encryption
- SSL certificate based authentication
- Bandwidth regulation
- Variable pre-load cache (#/size of pages)
- Load Balancing/Connection Redirection
- Cache-Server
  - Support for different cache levels:
    - main/global (4)
    - regional (2)
    - local (1)
    - no cache (0)
  - Variable cache size
  - GUID file identifications
- Transfer routing
- Cache routing
- Cache route lookup
- CMD interface +

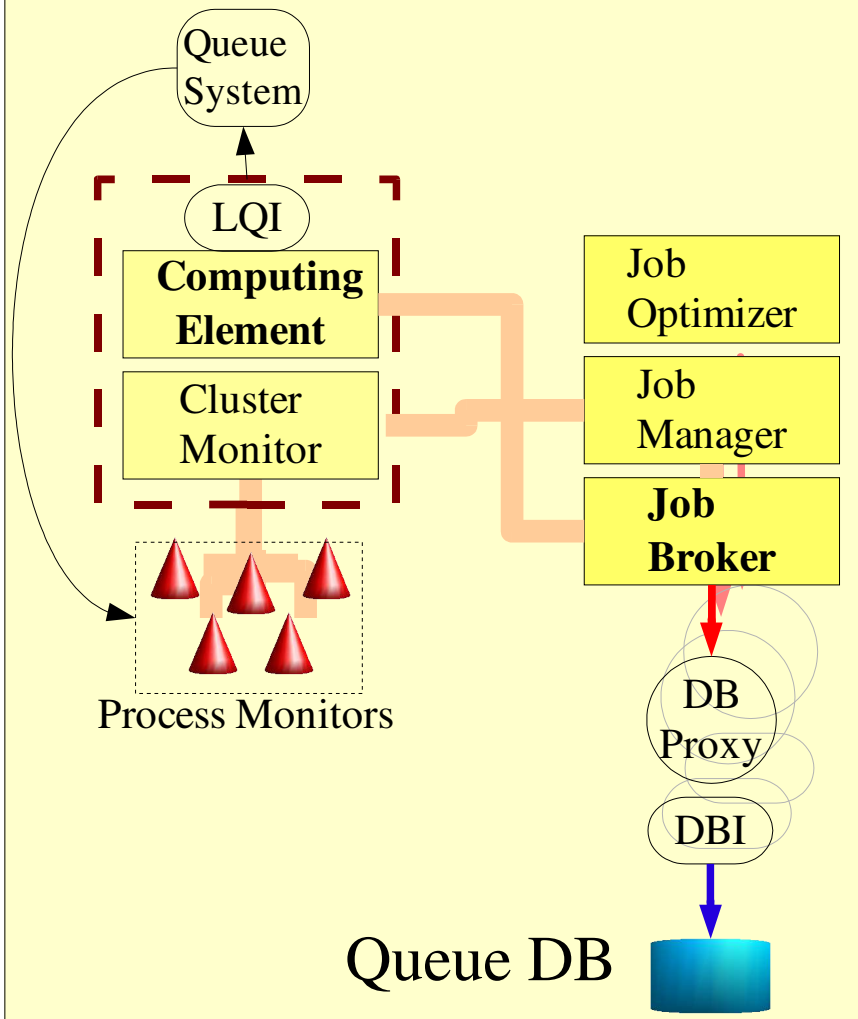
API Class for server acces

ClC Package contains :

| | | |
|---|---|---|
| aiod | - | Server |
| aioget | - | 'get' client |
| aioput | - | 'put' client |
| aiolookup | - | Cache lookup |
| guidtool | - | GUID creation |
| libalienio | - | Client library |

# AliEn Queue System

- Jobs described in **JDL** (Condor) syntax
- Jobs execute registered commands/installed packages
- Job Scheduler with passive "Pull" model:
  - CEs ask for jobs in regular intervals
- Job Optimizer allows "Pseudo-Push" model:
  - JDL modifications allow job assignment to a specific resource or a subset of resources
- Process Monitor Service reports job information about running jobs to the AliEn **/proc** filesystem
- CE acts as a queue system wrapper





# AliEn Job Description Example

## Running a ROOT macro

```
Executable    = "root";
Packages      = "ROOT::3.10.01";
Arguments     = "Command::ROOT -x macro.C";
InputData     = {"/alice/production/peters/*Tree.root”};
InputFile     = {"LF:/alice/user/p/peters/macro.C"};
OutputFile    = {"myhisto.root"};
```

**Simple and readable !**



# AliEn UI

## /proc filesystem

xwud: xwdump

peters on pb-d-128-141-47-124: /home/peters - Shell - Konsole <2>

Session Edit View Settings Help

```
[aliendb1.cern.ch:3307] / > ps -Xrs
Nov 20 00:48:19  notice (Re)making connection to ClusterMonitor: aliendb1.cern.ch:8084
aliprod    114977  --10-subjobs--          RS                      -      -                                    /bin/aliroot
aliprod    -114979 Alice::CERN::LXSHARE    R                       89     15.2   3353.3  48:47:05 2 6  551   /bin/aliroot
aliprod    115569  --100-subjobs--         RS                      -      -                                    /bin/aliroot
aliprod    115571  --100-subjobs--         RS                      -      -                                    /bin/aliroot
aliprod    -115588 Alice::Torino::PBS      R                       0      1.8    1.59    02:03:51 2 6  796   /bin/aliroot
aliprod    -115589 Alice::Torino::PBS      ST                      -      -                                    /bin/aliroot
aliprod    -115591 Alice::Torino::PBS      R                       0      1.8    1.59    02:02:56 2 6  796   /bin/aliroot
aliprod    -115593 Alice::Torino::PBS      R                       0      1.8    1.59    02:04:01 2 6  796   /bin/aliroot
aliprod    -115594 Alice::Torino::PBS      R                       0      1.8    1.59    02:03:51 2 6  796   /bin/aliroot
aliprod    -115596 Alice::Torino::PBS      R                       0      1.8    1.59    02:03:46 2 6  796   /bin/aliroot
aliprod    -115598 Alice::Torino::PBS      R                       0      1.8    1.59    02:03:35 2 6  796   /bin/aliroot
aliprod    -115601 Alice::Torino::PBS      R                       0      1.8    1.59    02:03:24 2 6  796   /bin/aliroot
aliprod    -115603 Alice::Torino::PBS      R                       0      1.8    1.26    02:03:33 2 6  1263  /bin/aliroot
aliprod    -115605 Alice::Torino::PBS      R                       0      1.8    1.26    02:03:27 2 6  1263  /bin/aliroot
aliprod    -115628                         A                       -      -                                    /bin/aliroot
aliprod    -115630 Alice::Torino::PBS      R                       0      1.8    1.26    02:02:14 2 6  1263  /bin/aliroot
aliprod    -115631 Alice::Torino::PBS      R                       0      1.7    1.26    02:01:43 2 6  1263  /bin/aliroot
aliprod    -115632 Alice::Torino::PBS      R                       0      1.7    1.26    02:01:45 2 6  1263  /bin/aliroot
aliprod    -115633 Alice::Torino::PBS      R                       0      1.6    1.26    02:01:38 2 6  1263  /bin/aliroot
aliprod    -115634 Alice::Torino::PBS      R                       0      1.6    1.26    02:01:21 2 6  1263  /bin/aliroot
aliprod    -115635 Alice::Torino::PBS      R                       0      1.4    1.26    02:01:37 2 6  1263  /bin/aliroot
aliprod    -115636 Alice::Torino::PBS      R                       0      1.8    1       02:01:31 2 6  999   /bin/aliroot
aliprod    -115637 Alice::Torino::PBS      R                       0      1.4    1.26    02:02:11 2 6  1263  /bin/aliroot
aliprod    -115638 Alice::Torino::PBS      R                       0      1.3    1.26    02:01:14 2 6  1263  /bin/aliroot
aliprod    -115639 Alice::Torino::PBS      R                       0      1.8    1       02:01:21 2 6  999   /bin/aliroot
aliprod    -115640 Alice::Torino::PBS      R                       0      1.4    1.26    02:01:37 2 6  1263  /bin/aliroot
aliprod    -115641 Alice::Torino::PBS      R                       0      1.8    1       02:01:17 2 6  999   /bin/aliroot
aliprod    -115642 Alice::Torino::PBS      R                       0      1.2    1.26    02:01:39 2 6  1263  /bin/aliroot
aliprod    -115643 Alice::Torino::PBS      R                       0      1.3    1.26    02:01:11 2 6  1263  /bin/aliroot
aliprod    -115644 Alice::Torino::PBS      R                       0      1.8    1       02:01:45 2 6  999   /bin/aliroot
aliprod    -115645 Alice::Torino::PBS      R                       0      1.8    1.59    02:00:57 2 6  796   /bin/aliroot
aliprod    -115646 Alice::Torino::PBS      R                       0      1.8    1.59    02:00:52 2 6  796   /bin/aliroot
aliprod    -115647                         A                       -      -                                    /bin/aliroot
aliprod    -115648                         A                       -      -                                    /bin/aliroot
aliprod    116076  --100-subjobs--         RS                      -      -                                    /bin/aliroot
aliprod    116077  --100-subjobs--         RS                      -      -                                    /bin/aliroot
aliprod    116078  --100-subjobs--         RS                      -      -                                    /bin/aliroot
aliprod    -116351 Alice::FZK::PBS         Q                       -      -                                    /bin/aliroot
aliprod    -116356 Alice::FZK::PBS         Q                       -      -                                    /bin/aliroot
aliprod    -116359 Alice::FZK::PBS         Q                       -      -                                    /bin/aliroot
aliprod    -116363 Alice::FZK::PBS         Q                       -      -                                    /bin/aliroot
aliprod    -116397 Alice::FZK::PBS         Q                       -      -                                    /bin/aliroot
aliprod    -116401 Alice::FZK::PBS         Q                       -      -                                    /bin/aliroot
aliprod    -116404 Alice::FZK::PBS         Q                       -      -                                    /bin/aliroot
aliprod    -116407 Alice::FZK::PBS         Q                       -      -                                    /bin/aliroot
aliprod    -116448 Alice::FZK::PBS         Q                       -      -                                    /bin/aliroot
aliprod    -116455 Alice::FZK::PBS         Q                       -      -                                    /bin/aliroot
[aliendb1.cern.ch:3307] / >
```

New Shell



# AliEn UI

## Queue system site statistics

xwud: xwdump

peters on pb-d-128-141-47-124: /home/peters - Shell - Konsole <2>

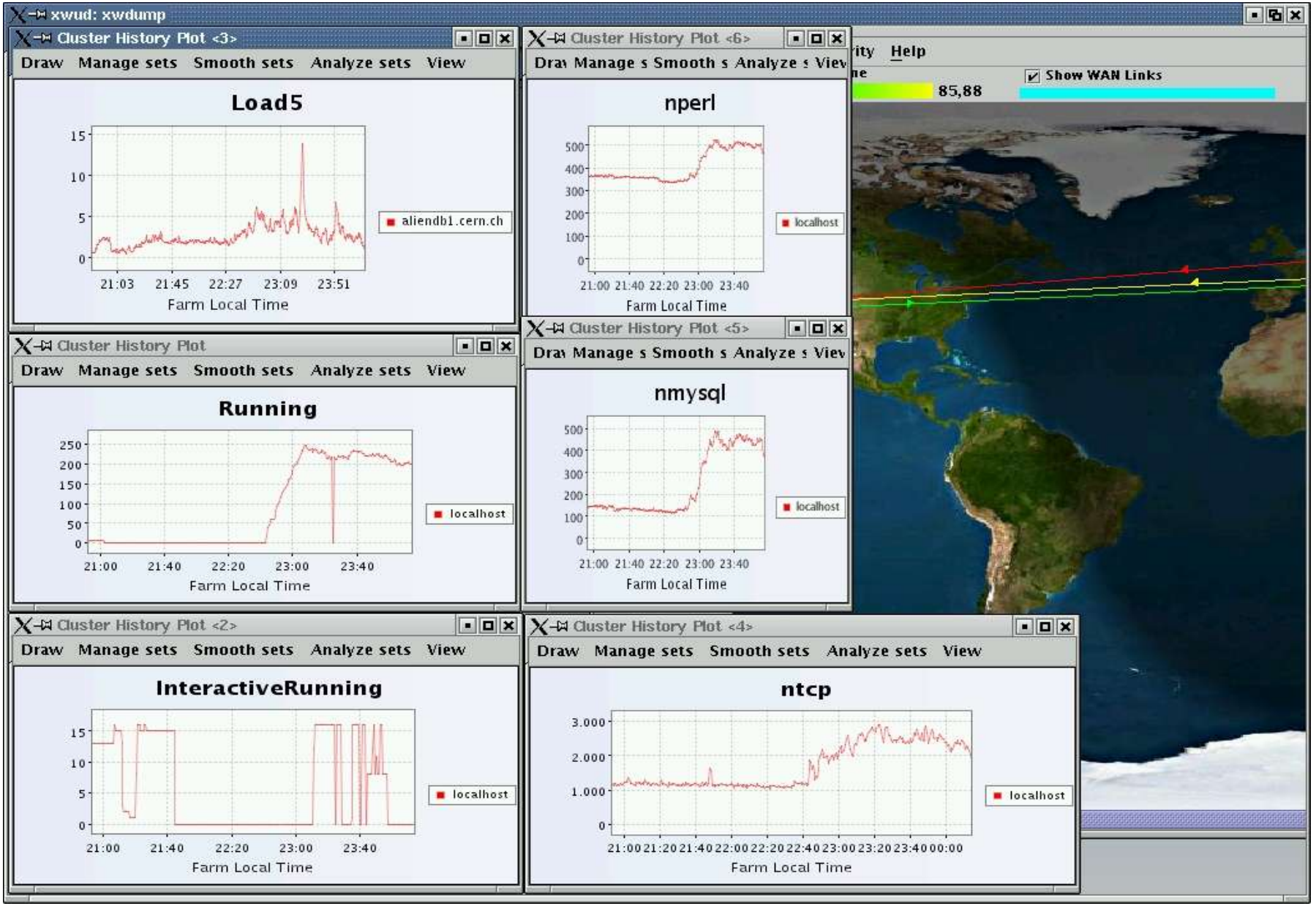
Session Edit View Settings Help

```
  RSize [Mb]                    0.00                  0.00
  VSize [Mb]                    0.00                  0.00

================================================================================
= Site Statistic
--------------------------------------------------------------------------------
  Site                          Done  Run   Queu  Start Error Idle  Iact
  Alice::Bari::PBS              0     0     0     0     0     0     0
  Alice::Bergen::PBS            1     0     0     0     0     0     0
  Alice::Calcutta::PBS          0     0     0     0     0     0     0
  Alice::Catania::PBS           1     0     0     0     0     0     0
  Alice::CCIN2P3::BQS           2     0     0     0     0     0     0
  Alice::CERN::FAKE             0     0     0     0     0     0     0
  Alice::CERN::LXSHARE          1896  1     0     0     2     0     0
  Alice::CERN::Oplapro          55    0     0     0     0     13    0
  Alice::CERN::PCEPALICE45      2     0     0     0     0     0     0
  Alice::CNAF::PBS              7     0     0     0     0     0     0
  Alice::Cyfronet::PBS          13    0     0     0     0     0     0
  Alice::FZK::PBS               1132  0     10    0     0     0     0
  Alice::GSI::LSF               10    0     0     0     0     0     0
  Alice::Houston::PBS           0     0     0     0     0     0     0
  Alice::IHEP::PBS              0     0     0     0     0     0     0
  Alice::ITEP::RRC              0     0     0     0     0     0     0
  Alice::JINR::PBS              8     0     0     0     0     0     0
  Alice::LBL::LSF               3     0     0     0     0     0     0
  Alice::LCG::Torino            14    0     0     0     0     0     0
  Alice::OSC::PBS               0     0     0     0     0     0     0
  Alice::Padova::LSF            10    0     0     0     0     0     0
  Alice::Prague::PBS            568   0     0     0     0     8     0
  Alice::SUBATECH::PBS          7     0     0     0     0     0     0
  Alice::Torino::PBS            187   26    0     1     0     0     0
================================================================================
[aliendb1.cern.ch:3307] / >
```

New Shell

# AliEn Monitoring – MonaLisa

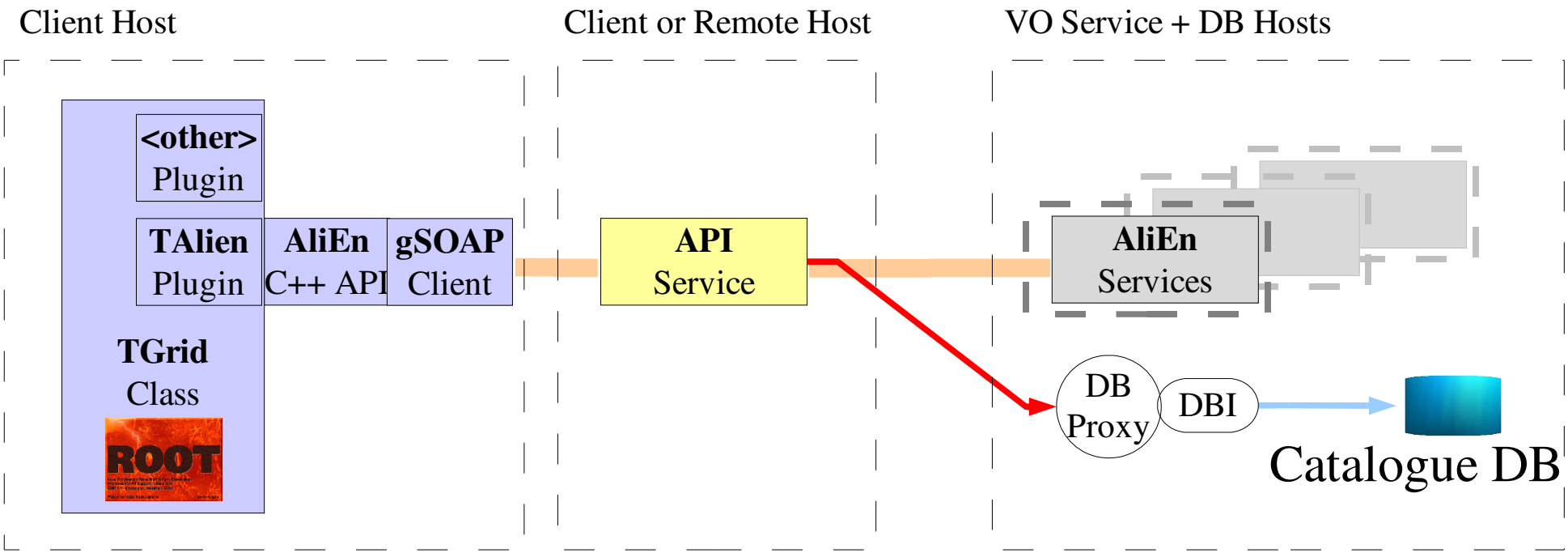




- Combining AliEn and ROOT



# Jointventure of AliEn + ROOT




- AliEn Services + Catalogue are accessible via the ROOT TAlien (**TGrid**) class
- TAlien uses the SOAP based AliEn C++ API

Examples:

- **`TGrid::Connect("alien://aliendb1:15000/?direct","");`**

// initializes gGrid with AliEn plugin (API server at aliendb1, port 15000)

- **`gGrid->mkdir("/alice/acat03");`**

// create directory in virtual file catalogue



# TGrid.h – Prototypes

## //--- file catalog browsing

```
virtual Grid_ResultHandle_t OpenDir(const char *ldn) = 0;
virtual Grid_Result_t *ReadResult(Grid_ResultHandle_t hResult) = 0;
virtual void CloseResult(Grid_ResultHandle_t hResult) = 0;
virtual void ResetResult(Grid_ResultHandle_t hResult) = 0;
```

## //--- file catalog management

```
virtual Int_t Mkdir(const char *ldn, Bool_t recursive = kFALSE) = 0;
virtual Int_t Rmdir(const char *dir, Bool_t recursive = kFALSE) = 0;
virtual Int_t Rm(const char *lfn, Bool_t recursive = kFALSE) = 0;
virtual Int_t Cp(const char *sourcelfn, const char *targetlfn) = 0;
virtual Int_t Mv(const char *sourcelfn, const char *targetlfn) = 0;
virtual Int_t Chmod(const char *lfn, UInt_t mode) = 0;
virtual Int_t Chown(const char *lfn, const char *owner,
                    const char *group) = 0;
virtual Int_t AddFile(const char *newlfn, const char *pfn, Int_t size = -1,
                      const char *msn = 0, char *guid = 0) = 0;
virtual Int_t AddFileMirror(const char *lfn, const char *pfn,
                            const char *msn) = 0;
virtual Int_t RegisterFile(const char *lfn, const char *pfn,
                           const char *msn = "") = 0;
virtual char *GetFile(const char *lfn, const char *localdest = 0) = 0;
virtual Grid_ResultHandle_t GetPhysicalFileNames(const char *lfn) = 0;
```

## //--- file catalog queries

```
virtual Grid_ResultHandle_t Find(const char *path, const char *file,
                                 const char *conditions = 0) = 0;
virtual Grid_ResultHandle_t FindEx(const char *path, const char *file,
                                   const char *conditions = 0) = 0;
```

## //--- file catalog meta data management

```
virtual Int_t AddTag(const char *ldn, const char *tagName) = 0;
virtual Int_t RemoveTag(const char *ldn, const char *tagName) = 0;
virtual Grid_ResultHandle_t GetTags(const char *ldn) = 0;
virtual Int_t AddAttributes(const char *lfn, const char *tagName,
                            Int_t inargs, ...) = 0;
virtual Int_t AddAttribute(const char *lfn, const char *tagName,
                           const char *attrname, const char *attrval) = 0;
virtual Int_t DeleteAttribute(const char *lfn, const char *tagName,
                              const char *attrname) = 0;
virtual Grid_ResultHandle_t GetAttributes(const char *lfn,
                                          const char *tagName) = 0;
```

## //--- job management

```
virtual Grid_JobId_t      SubmitJob(const char *jdlFile) = 0;
virtual Grid_JobStatus_t *GetJobStatus(Grid_JobId_t jobId) = 0;
virtual Int_t             KillJob(Grid_JobId_t jobId) = 0;
virtual Grid_JobId_t      ResubmitJob(Grid_JobId_t jobId) = 0;
```

## //--- file access

```
virtual Grid_AccessPath_t *GetAccessPath(const char *lfn, Bool_t mode =
                                         const char *msn = 0) = 0;
virtual char *GetFileUrl(const char *msn, const char *path) = 0;
```

## //--- file access posix interface

```
virtual Grid_FileHandle_t GridOpen(const char *lfn, Int_t flags,
                                   UInt_t mode = 0) = 0;
virtual Int_t GridClose(Grid_FileHandle_t handle) = 0;
virtual Int_t GridRead(Grid_FileHandle_t handle, void *buffer,
                       Long_t size, Long64_t offset) = 0;
virtual Int_t GridWrite(Grid_FileHandle_t handle, void *buffer,
                        Long_t size, Long64_t offset) = 0;
virtual Int_t GridFstat(Grid_FileHandle_t handle,
                        gridstat_t *statbuf) = 0;
virtual Int_t GridFsync(Grid_FileHandle_t handle) = 0;
virtual Int_t GridFchmod(Grid_FileHandle_t handle, UInt_t mode) = 0;
virtual Int_t GridFchown(Grid_FileHandle_t handle, UInt_t owner,
                         UInt_t group) = 0;
virtual Int_t GridLink(const char *source, const char *target) = 0;
virtual Int_t GridSymlink(const char *source, const char *target) = 0;
virtual Int_t GridReadlink(const char *lfn, char *buf, size_t bufsize) =

virtual Int_t GridStat(const char *lfn, gridstat_t *statbuf) = 0;
virtual Int_t GridLstat(const char *lfn, gridstat_t *statbuf) = 0;

virtual Grid_FileHandle_t GridOpendir(const char *dir) = 0;
virtual const Grid_FileEntry_t *GridReaddir(Grid_FileHandle_t handle) =
virtual Int_t GridClosedir(Grid_FileHandle_t handle) = 0;
```

## //--- PROOF interface

```
virtual void SetGridProof(TGridProof *proof) { fProof = proof; }
virtual TGridProof *GetGridProof() const { return fProof; }
virtual Grid_ProofSession_t *RequestProofSession(const char *user,
                                                 Int_t nsites,
                                                 void **sites,
                                                 void **ntimes,
                                                 time_t starttime,
                                                 time_t duration) = 0;
virtual Grid_ProofSessionStatus_t
        GetProofSessionStatus(Grid_ProofSession_t *proofSession) = 0;
virtual void   ListProofDaemons() = 0;
virtual void   ListProofSessions(Int_t sessionId = 0) = 0;
virtual Bool_t KillProofSession(Int_t sessionId) = 0;
virtual Bool_t KillProofSession(Grid_ProofSession_t *proofSession) = 0;
```

## //--- plugin factory

```
virtual TGridResult *CreateGridResult(Grid_ResultHandle_t handle) = 0;
virtual TGridProof  *CreateGridProof() = 0;
```



# Task Splitting in AliEn

**1 Job Spawning:**

- a production job is spawned <n> times by the Job Optimizer

**2 File based Splitting:**

- a task is split into one job for each input data file

**3 Storage Location Splitting:**

- a task is split into one job per storage system

**4a/b File size/number based Splitting:**

- a task is split into one job for a group of input data files with a maximum input data size or maximum number of files

**5 Combinations of 3+4a & 3+4b & 3+4a+4b**



# Batch Analysis AliEn + ROOT

- Task splitting is executed by the AliEn JobOptimizer
- From the ROOT prompt
  - → Input data query
  - → Registration of input files and macros
  - → JDL creation
  - → Submission of single job requests, which are spawned afterwards
  - → Status Check
  - → Interactive result file merging
  - → Batch result file merging



# Batch Analysis AliEn + ROOT

Since the task splitting is defined in the JDL, we can commit any kind of job from the ROOT prompt using the approriate JDL syntax:

```
gGrid->SubmitJob("<jdlfile> [parameter1] [parameter2] .... ");
```

E.g. for a production job with 100 spawned subjobs:

```
gGrid->SubmitJob("/alice/jdl/AliRootProd.jdl myproductiondir 100");
```

For analysis specify SE and file size based job splitting and put as input data a query with the specific data e.g. **ana.jdl:**

```
..........
InputData={"/alice/production/aliprod/prod001/*galice.root"};
Split="SE";
MaxInputFileSize="100000000";
MaxInputFileNumber="10";
```



# Batch Analysis – Result Merging

To merge automatically histogram files of submitted analysis job, task splitting with storage location and a maximum number of files can be used:

- 1st in each site locally the results and
- 2nd the premerged results of all sites.

The 2nd job depends on the 1st , in the JDL one has to specify:

```
JobPrecessor={<jobId 1st >}
```



# Interactive Analysis with PROOF

Basic requirements:

- Analysis data has to be stored in ROOT files (TTrees or Tkeys)

- PROOF servers have to load shared libraries for user and experiment code

- Analysis code has to be inserted in the automatically generated selector macro for the object to be analyzed:

```
obj->MakeSelector();
```

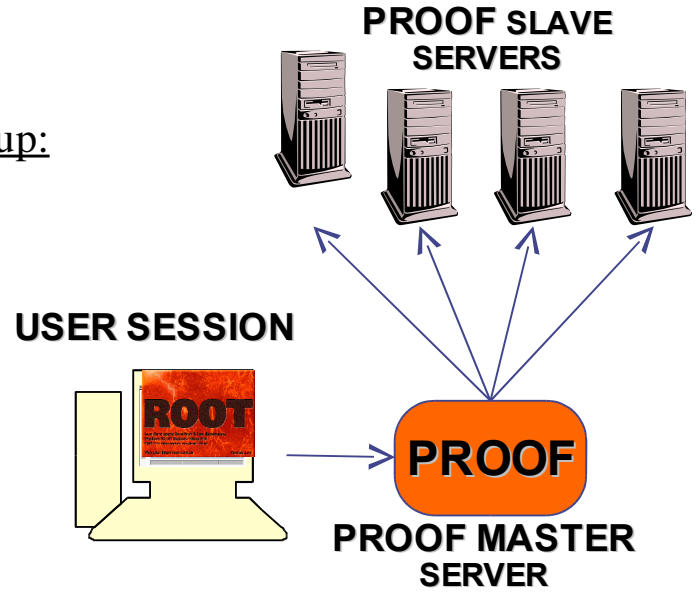
Recipe:

- **Store your objects in trees**
- **Use the selector macro for analysis code**



- PROOF allows interactive analysis on local clusters with a static master/slave configuration

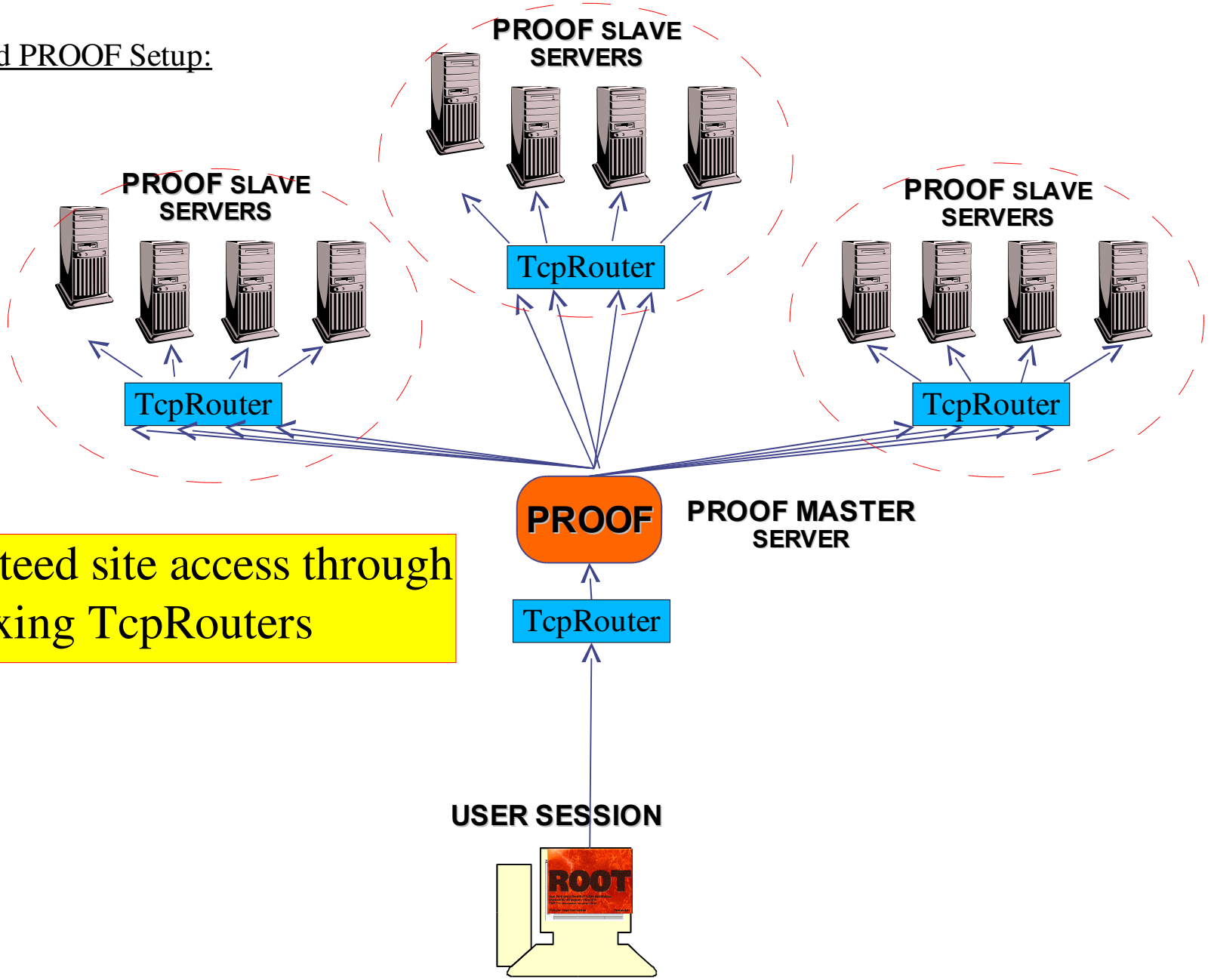
Classical PROOF Setup:




- In the GRID Environment, resources are distributed and temporary:
  - ➔ no guaranteed incoming access to every possible slave server
  - ➔ resources are dynamic and not statically available

# Interactive Analysis with AliEn + PROOF

AliEn Grid PROOF Setup:




- Guaranteed site access through multiplexing TcpRouters



# Interactive Analysis with AliEn + PROOF

- **Site Access**
  - TcpRouting Service for connection forwarding to 'idle' proofd's
    - → retrieves information about local proofd's from the queue system
    - → does blind packet forwarding
    - → established connections change status of proofd to 'interactive'

- **Master Access**
  - access through temporary TcpRouter to connect to hidden port
  - access is gained like in a booking system for a reserved time

- **Authentication**
  - PROOF master authenticates with a encrypted secret password to site daemons - encrypted password is distributed via the TcpRouter service
  - PROOF client authenticates with a different temporary password retrieved with the AliEn API



# Interactive Analysis with AliEn + PROOF

## Work Distribution

- Interactive analysis with PROOF steered by a data packetizer

- In a local cluster:
  - ➔ cluster wide accessible data can be processed by all slaves
    - ➔ packet takeover by all slaves

- In a grid environment:
  - ➔ site wide accessible data can be processed by all slaves
    - ➔ packet takeover by all slaves within one site



# Interactive Analysis with AliEn + PROOF

## Daemon Population + Reservation

- Daemons can be started manually with a special interactive JDL tag on a dedicated site

- Daemon assignment through dedicated PROOF service:
  - corresponding to accessibility of input data
  - availability of daemons and resources
  - limited duration
  - identified by session ID

- PROOF population service in preparation:
  - dynamic increase and decrease of proofd population
    - depending on available resources
    - depending on static population configuration per site
    - depending on booking requests

# Interactive Analysis with AliEn + PROOF

## Sample Session: Connect/Query

xwud: xwdump

xterm

```
rot: Command not found.
[lxplus040] ~/alien-afs/sc2003 > root
  ********************************************
  *                                          *
  *       W E L C O M E  to  R O O T         *
  *                                          *
  *   Version   3.10/01  17 November 2003    *
  *                                          *
  *  You are welcome to visit our Web site   *
  *          http://root.cern.ch             *
  *                                          *
  ********************************************

FreeType Engine v2.1.3 used to render TrueType fonts.
Compiled for linux with thread support.

CINT/ROOT C/C++ Interpreter version 5.15.110, Nov 9 2003
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
root [0] .L display.C+
.L sc
root [1] .L scriptnewDispl.C
root [2] prepare()
Setting API Server to URL: http://aliendb1.cern.ch:15000
Welcome to the AliEn Grid Services at http://aliendb1.cern.ch:15000 !
root [3] add("/alice/production/aliprod/fzkprod-010/","ITSold*.root");
-----------------------------------------------------------
     1      LFN: /alice/production/aliprod/fzkprod-010/113570/ITSold.Tracks.root SZ:      11603 PERM: 1ed TIME: 1068816600
            PFN: file://c01-005-109.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00036.1068776284    MSN: Alice::FZK::File
     2      LFN: /alice/production/aliprod/fzkprod-010/113571/ITSold.Tracks.root SZ:      11603 PERM: 1ed TIME: 1068816600
            PFN: file://c01-005-110.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00004.1068776317    MSN: Alice::FZK::File
     3      LFN: /alice/production/aliprod/fzkprod-010/113572/ITSold.Tracks.root SZ:       9890 PERM: 1ed TIME: 1068816600
            PFN: file://c01-005-111.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00005.1068776317    MSN: Alice::FZK::File
     4      LFN: /alice/production/aliprod/fzkprod-010/113573/ITSold.Tracks.root SZ:       9523 PERM: 1ed TIME: 1068816600
            PFN: file://c01-005-112.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00018.1068776370    MSN: Alice::FZK::File
     5      LFN: /alice/production/aliprod/fzkprod-010/113574/ITSold.Tracks.root SZ:      10803 PERM: 1ed TIME: 1068816600
            PFN: file://c01-005-113.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00037.1068776410    MSN: Alice::FZK::File
     6      LFN: /alice/production/aliprod/fzkprod-010/113575/ITSold.Tracks.root SZ:      10030 PERM: 1ed TIME: 1068816600
            PFN: file://c01-005-114.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00044.1068776426    MSN: Alice::FZK::File
     7      LFN: /alice/production/aliprod/fzkprod-010/113576/ITSold.Tracks.root SZ:       9879 PERM: 1ed TIME: 1068816600
            PFN: file://c01-005-115.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00032.1068776396    MSN: Alice::FZK::File
     8      LFN: /alice/production/aliprod/fzkprod-010/113577/ITSold.Tracks.root SZ:      10045 PERM: 1ed TIME: 1068816600
            PFN: file://c01-005-116.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00033.1068776406    MSN: Alice::FZK::File
     9      LFN: /alice/production/aliprod/fzkprod-010/113578/ITSold.Tracks.root SZ:      10377 PERM: 1ed TIME: 1068816600
            PFN: file://c01-005-117.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00042.1068776421    MSN: Alice::FZK::File
    10      LFN: /alice/production/aliprod/fzkprod-010/113579/ITSold.Tracks.root SZ:      10575 PERM: 1ed TIME: 1068816600
            PFN: file://c01-005-118.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00053.1068776452    MSN: Alice::FZK::File
    11      LFN: /alice/production/aliprod/fzkprod-010/114638/ITSold.Tracks.root SZ:      10028 PERM: 1ed TIME: 1069065240
            PFN: file://c01-004-117.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00142.1069064992    MSN: Alice::FZK::File
    12      LFN: /alice/production/aliprod/fzkprod-010/114639/ITSold.Tracks.root SZ:      10028 PERM: 1ed TIME: 1069065240
            PFN: file://c01-004-118.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00143.1069064992    MSN: Alice::FZK::File
    13      LFN: /alice/production/aliprod/fzkprod-010/114640/ITSold.Tracks.root SZ:      10028 PERM: 1ed TIME: 1069065240
            PFN: file://c01-004-119.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00141.1069064992    MSN: Alice::FZK::File
    14      LFN: /alice/production/aliprod/fzkprod-010/114641/ITSold.Tracks.root SZ:       9877 PERM: 1ed TIME: 1069065240
            PFN: file://c01-004-120.gridka.de/grid/fzk.de/alice/alice1/AliEn/save/00001/00172.1069065071    MSN: Alice::FZK::File
```

# Interactive Analysis with AliEn + PROOF

## Sample Session: proofd information/request

xwud: xwdump

xterm

```
    40      LFN: /alice/production/aliprod/cernprod001/112220/ITSold.Tracks.root SZ:      10568 PERM: 1ed TIME: 1068762900
            PFN: castor://lxb0337.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00030.1068748399    MSN: Alice::CERN::Castor
    41      LFN: /alice/production/aliprod/cernprod001/112221/ITSold.Tracks.root SZ:      10553 PERM: 1ed TIME: 1068762900
            PFN: castor://lxb0327.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00028.1068748363    MSN: Alice::CERN::Castor
    42      LFN: /alice/production/aliprod/cernprod001/112222/ITSold.Tracks.root SZ:      10795 PERM: 1ed TIME: 1068762900
            PFN: castor://lxbatch230.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00117.1068747546    MSN: Alice::CERN::Castor
    43      LFN: /alice/production/aliprod/cernprod001/112224/ITSold.Tracks.root SZ:      10566 PERM: 1ed TIME: 1068762900
            PFN: castor://lxbatch342.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00017.1068748276    MSN: Alice::CERN::Castor
    44      LFN: /alice/production/aliprod/cernprod001/112225/ITSold.Tracks.root SZ:      10556 PERM: 1ed TIME: 1068762900
            PFN: castor://lxb0590.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00121.1068747577    MSN: Alice::CERN::Castor
    45      LFN: /alice/production/aliprod/cernprod001/112226/ITSold.Tracks.root SZ:       9518 PERM: 1ed TIME: 1068762960
            PFN: castor://lxb0081.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00039.1068748503    MSN: Alice::CERN::Castor
    46      LFN: /alice/production/aliprod/cernprod001/112227/ITSold.Tracks.root SZ:      11202 PERM: 1ed TIME: 1068762960
            PFN: castor://lxbatch652.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00002.1068748033    MSN: Alice::CERN::Castor
    47      LFN: /alice/production/aliprod/cernprod001/112228/ITSold.Tracks.root SZ:      11197 PERM: 1ed TIME: 1068762960
            PFN: castor://lxb0177.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00119.1068747575    MSN: Alice::CERN::Castor
    48      LFN: /alice/production/aliprod/cernprod001/112230/ITSold.Tracks.root SZ:      10561 PERM: 1ed TIME: 1068762960
            PFN: castor://lxb0472.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00123.1068747639    MSN: Alice::CERN::Castor
    49      LFN: /alice/production/aliprod/cernprod001/112231/ITSold.Tracks.root SZ:       9892 PERM: 1ed TIME: 1068762960
            PFN: castor://lxb0359.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00001.1068747688    MSN: Alice::CERN::Castor
    50      LFN: /alice/production/aliprod/cernprod001/112233/ITSold.Tracks.root SZ:       9893 PERM: 1ed TIME: 1068762960
            PFN: castor://lxb0222.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00005.1068747776    MSN: Alice::CERN::Castor
    51      LFN: /alice/production/aliprod/cernprod001/112235/ITSold.Tracks.root SZ:      10035 PERM: 1ed TIME: 1068762960
            PFN: castor://lxb0220.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00125.1068747640    MSN: Alice::CERN::Castor
    52      LFN: /alice/production/aliprod/cernprod001/112236/ITSold.Tracks.root SZ:      11192 PERM: 1ed TIME: 1068762960
            PFN: castor://lxb0522.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00013.1068748192    MSN: Alice::CERN::Castor
    53      LFN: /alice/production/aliprod/cernprod001/112237/ITSold.Tracks.root SZ:       9318 PERM: 1ed TIME: 1068762960
            PFN: castor://lxbatch136.cern.ch/castor/cern.ch/user/a/aliprod/AliEn-1.0/data/00001/00020.1068748313    MSN: Alice::CERN::Castor
-------------------------------------------------------
root [5] session()
root [6] daemons()
SITE                    avai used  tot free%
Alice::CERN::LXSHARE       0    0    0 0.00
Alice::Padova::LSF         0    0    0 0.00
Alice::FZK::PBS           10    0   10 100.00
Alice::CERN::FAKE          0    0    0 0.00
Alice::Prague::PBS         0    0    0 0.00
Alice::CERN::Oplapro      12    0   12 100.00
Alice::Torino::PBS         0    0    0 0.00
Alice::CNAF::PBS           0    0    0 0.00
0                          0    0    0 0.00
root [7] request()
MSN: Alice::FZK::File               nfiles: 20      ndaemon: -1      data[bytes]:          203782
MSN: Alice::CERN::Castor            nfiles: 53      ndaemon: -1      data[bytes]:          544579
-------------------------------------------------------
[ 2003_11_26 15:12.28 ] Info in <TAlienProof::DSetMsnExtraction>: request   20 daemons for site Alice::FZK::File
[ 2003_11_26 15:12.28 ] Info in <TAlienProof::DSetMsnExtraction>: request   53 daemons for site Alice::CERN::Castor
-------------------------------------------------------
[ 2003_11_26 15:12.32 ] Info in <TAlienProof::Request>: PROOF request accepted: your session ID is  603
-------------------------------------------------------
 id            user mux req ass scheduled            dur.     left
 603        aliprod  22  73  22 15:12.32 26.11.2003    300s    300s
-------------------------------------------------------
MSN: Alice::FZK::File               nfiles: 20      ndaemon: 10      data[bytes]:          203782
MSN: Alice::CERN::Castor            nfiles: 53      ndaemon: 12      data[bytes]:          544579
```



# Interactive Analysis with AliEn + PROOF

## Sample Session: connection to assigned proofd's

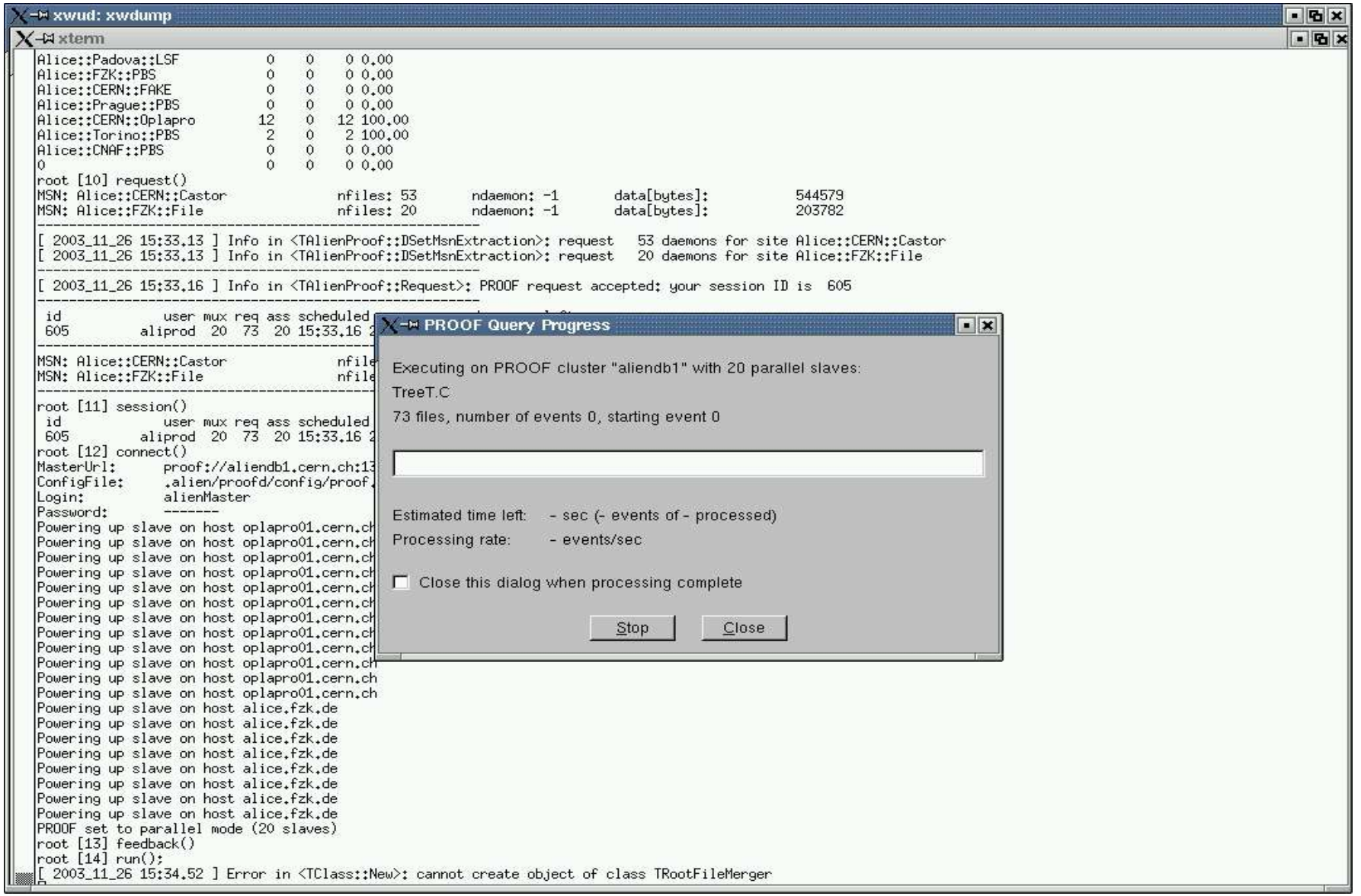
xwud: xwdump

xterm

```
root [5] session()
root [6] daemons()
SITE                        avai used  tot free%
Alice::CERN::LXSHARE           0    0    0 0.00
Alice::Padova::LSF             0    0    0 0.00
Alice::FZK::PBS               10    0   10 100.00
Alice::CERN::FAKE              0    0    0 0.00
Alice::Prague::PBS             0    0    0 0.00
Alice::CERN::Oplapro          12    0   12 100.00
Alice::Torino::PBS             0    0    0 0.00
Alice::CNAF::PBS               0    0    0 0.00
0                              0    0    0 0.00
root [7] request()
MSN: Alice::FZK::File                nfiles: 20       ndaemon: -1       data[bytes]:          203782
MSN: Alice::CERN::Castor             nfiles: 53       ndaemon: -1       data[bytes]:          544579
-----------------------------------------------------
[ 2003_11_26 15:12.28 ] Info in <TAlienProof::DSetMsnExtraction>: request   20 daemons for site Alice::FZK::File
[ 2003_11_26 15:12.28 ] Info in <TAlienProof::DSetMsnExtraction>: request   53 daemons for site Alice::CERN::Castor
-----------------------------------------------------
[ 2003_11_26 15:12.32 ] Info in <TAlienProof::Request>: PROOF request accepted: your session ID is  603
-----------------------------------------------------
 id             user mux req ass scheduled             dur.     left
 603         aliprod  22  73  22 15:12.32 26.11.2003    300s    300s
-----------------------------------------------------
MSN: Alice::FZK::File                nfiles: 20       ndaemon: 10       data[bytes]:          203782
MSN: Alice::CERN::Castor             nfiles: 53       ndaemon: 12       data[bytes]:          544579
-----------------------------------------------------
root [8] connect()
MasterUrl:      proof://aliendb1.cern.ch:13000
ConfigFile:     .alien/proofd/config/proof.603.conf.1069855952-0.859016508420126
Login:          alienMaster
Password:       -------
Powering up slave on host alice.fzk.de
Powering up slave on host alice.fzk.de
Powering up slave on host alice.fzk.de
Powering up slave on host alice.fzk.de
Powering up slave on host alice.fzk.de
Powering up slave on host alice.fzk.de
Powering up slave on host alice.fzk.de
Powering up slave on host alice.fzk.de
Powering up slave on host alice.fzk.de
Powering up slave on host alice.fzk.de
Powering up slave on host oplapro01.cern.ch
Powering up slave on host oplapro01.cern.ch
Powering up slave on host oplapro01.cern.ch
Powering up slave on host oplapro01.cern.ch
Powering up slave on host oplapro01.cern.ch
Powering up slave on host oplapro01.cern.ch
Powering up slave on host oplapro01.cern.ch
Powering up slave on host oplapro01.cern.ch
Powering up slave on host oplapro01.cern.ch
Powering up slave on host oplapro01.cern.ch
Powering up slave on host oplapro01.cern.ch
Powering up slave on host oplapro01.cern.ch
PROOF set to parallel mode (22 slaves)
```

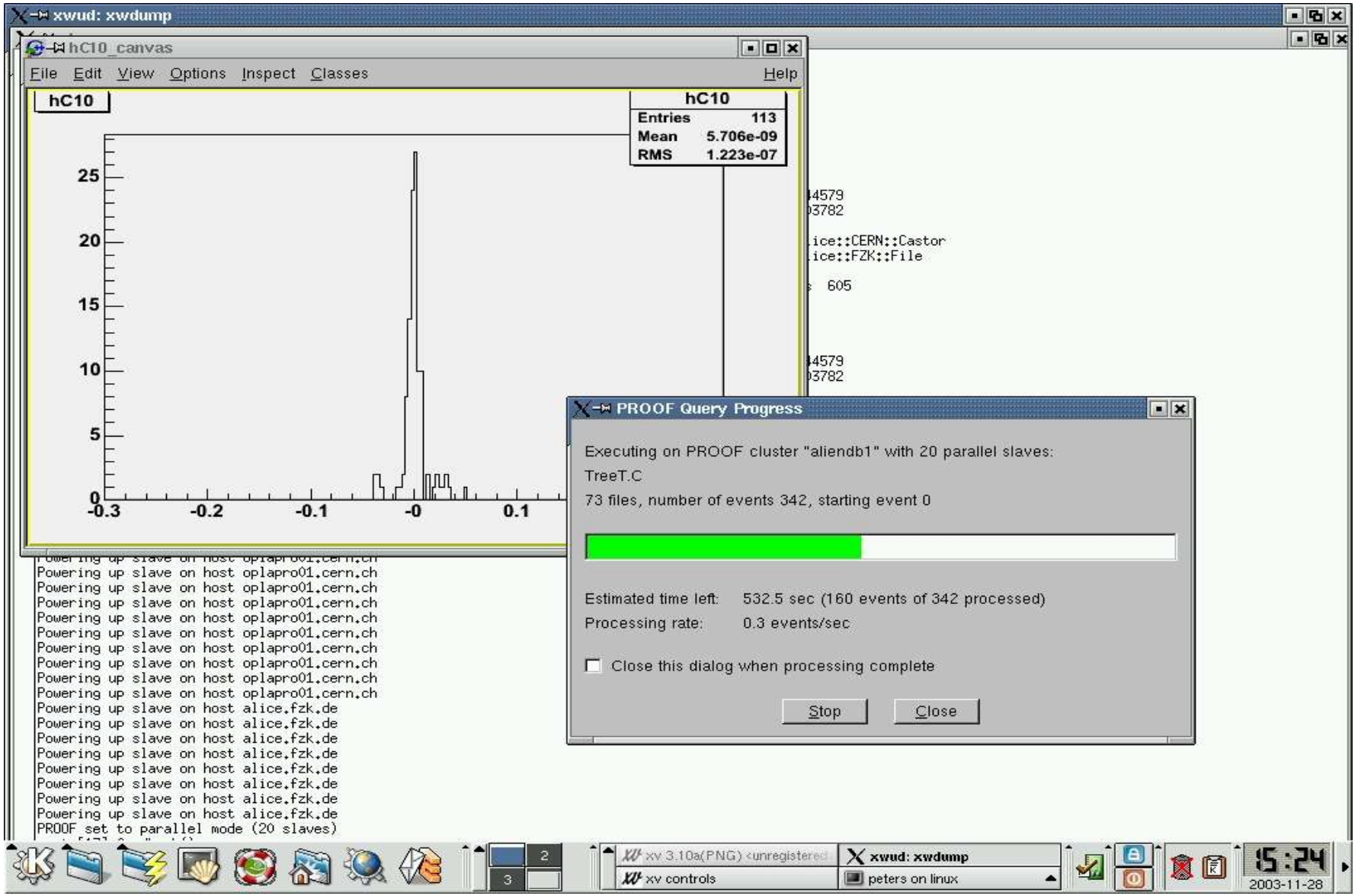
# Interactive Analysis with AliEn + PROOF

## Sample Session: data processing



# Interactive Analysis with AliEn + PROOF

Sample Session: data processing with feedback histogram





# Unification of Batch & Interactive Analysis with AliEn + PROOF

**Current implementation:**

- Datasets are represented by objects of the type TDSet in ROOT
- A GRID data query assigns data files to TDSet objects
- The "process" method initiates the interactive processing on the assigned GRID proof cluster

**To come:**

- The same "process" method initiates the batch processing of the same data set and automatically merging of the results

**ALICE will test the analysis facilities during the physics data challenge in early 2004**



# Outlook & Summary

- AliEn provides most of the required features of a GRID system for LHC experiments
- UI is getting very similar to Unix standards (/proc , df ...)
- AliEn modularity (distributed databases and services) allow a good scalability of the system
- AliEn will serve as a basis for the next service oriented GRID prototype at CERN (ARDA recommendation)
- AliEn was already used running **30.000** jobs in productions for the ALICE Physics Performance Report (PPR)
- AliEn will be used extensively during the upcoming ALICE physics data challenge (PDC04)

# Conclusions

- We are close having one solution for data analysis:
  - → **complete embedding of GRID functionality in ROOT**
  - → **common procedures for batch and interactive analysis**