The CERN Analysis Facility

A PROOF Cluster for Day-One Physics Analysis

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CERN/ALICE

CHEP 2007

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- The ALICE experiment
- The CERN Analysis Facility (CAF)
  - Concept and Structure
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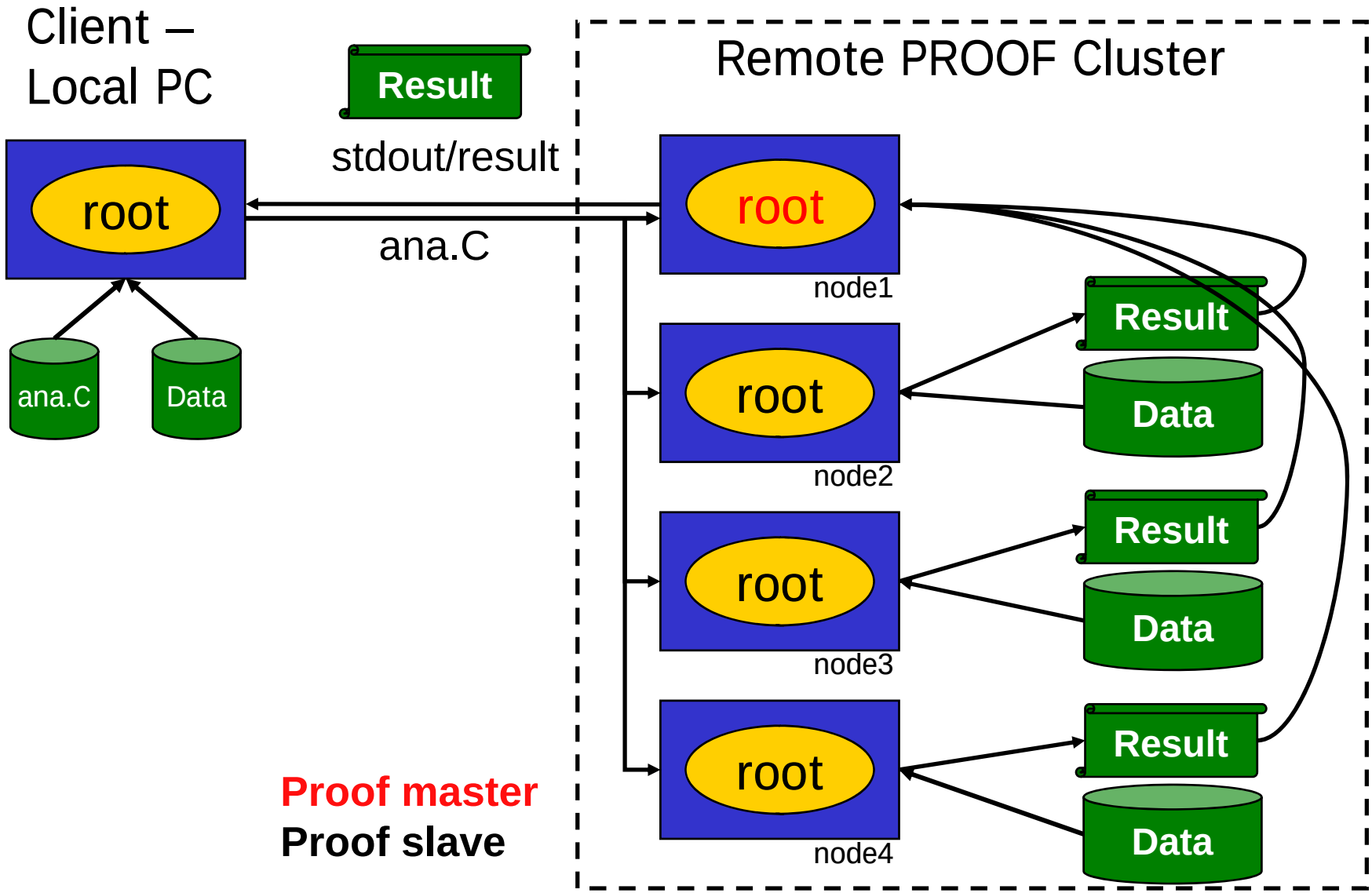
  - Datasets, data distribution & flow, staging from AliEn, CASTOR
  - Monitoring
  - Groups, disk quotas, CPU fairshare
  - Integration with ALICE's software framework AliRoot

PROOF

- Parallel ROOT Facility
- Interactive parallel analysis on a local cluster
  - Parallel processing of (local) data
  - Output handling with direct visualization
  - **Not** a batch system
- The usage of PROOF is transparent
  - The same code can be run locally and in a PROOF system (certain rules have to be followed)
- PROOF is part of ROOT

More details:
F. Rademakers
[307] Th, 15:20

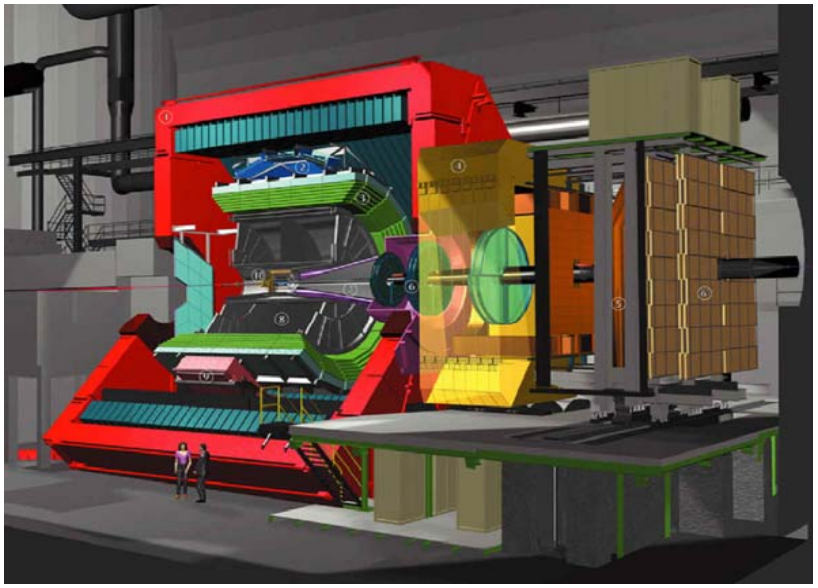
PROOF Schema



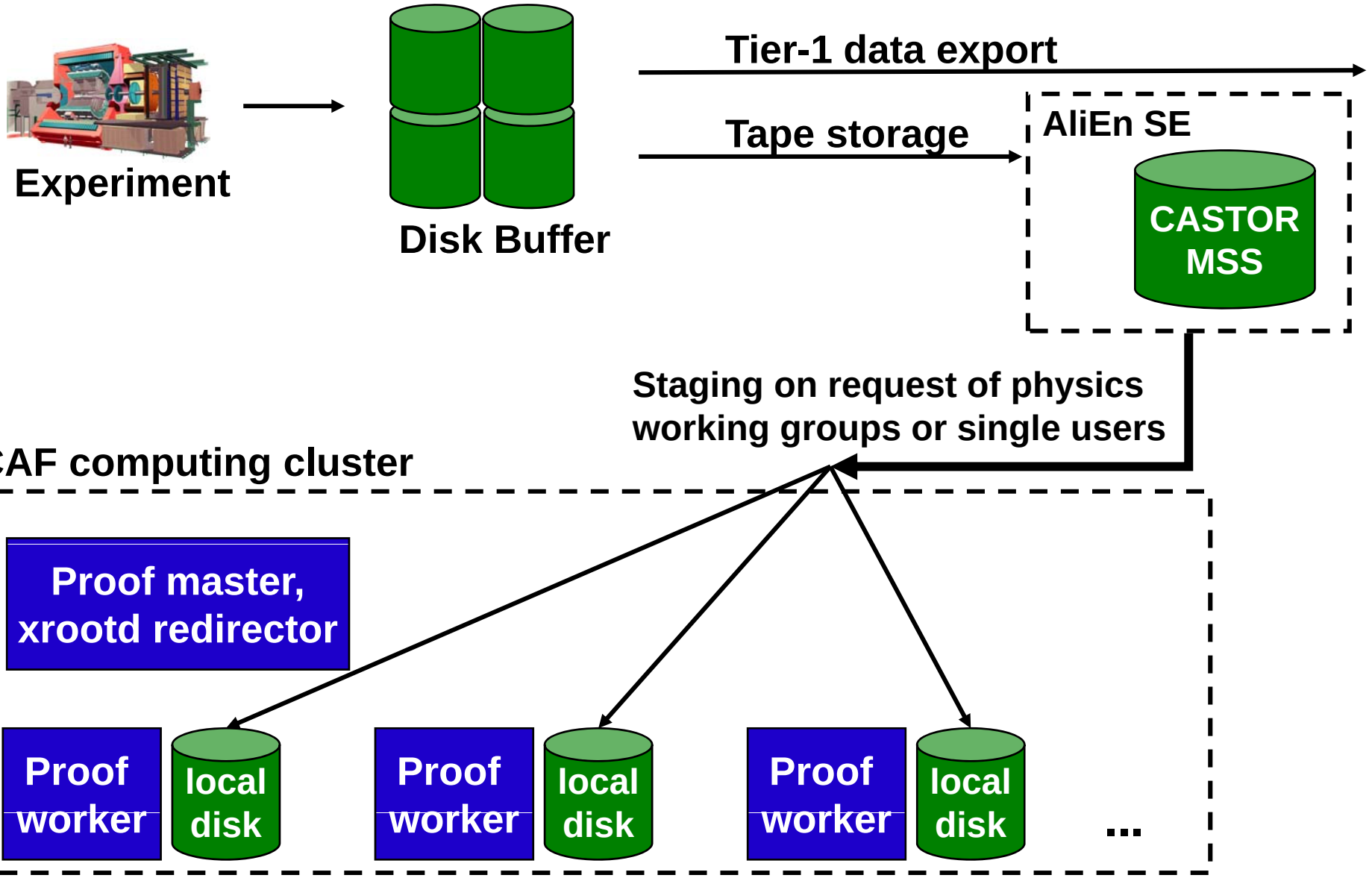
PROOF for ALICE

- ALICE (A Large Ion Collider Experiment) will study strongly interacting matter and the transition to the quark-gluon plasma
- The Grid is intensively used for simulation (now), reconstruction, storage and analysis (from 2008)
- A cluster called CERN Analysis Facility (CAF) running PROOF will allow
  - Prompt analysis of pp data
  - Pilot analysis of PbPb data
  - Fast simulation and reconstruction
  - Calibration & Alignment
  - Design goal: 500 CPUs, 100 TB of selected data locally available

  → Focus: Fast response time



CAF Schema


Experiment
Disk Buffer
Tier-1 data export
Tape storage
AliEn SE
CASTOR
MSS
Staging on request of physics
working groups or single users
CAF computing cluster
Proof master,
xrootd redirector
Proof
worker
local
disk
Proof
worker
local
disk
Proof
worker
local
disk
...

CAF – Test Setup

- Test setup in place since May 2006
  - 40 “standard” machines, 2 CPUs each, 250 GB disk
  - 2 Partitions: development (5 machines), production (35 machines)
- The cluster is a xrootd pool
  - 1 Machine: PROOF master and xrootd redirector
    - Several possible
  - Other machines: PROOF workers and xrootd disk servers
    - Access to local disks → Advantage of processing local data
- Testing led to a considerable amount of bug reports (most fixed ☺) and feature requests

Data distribution

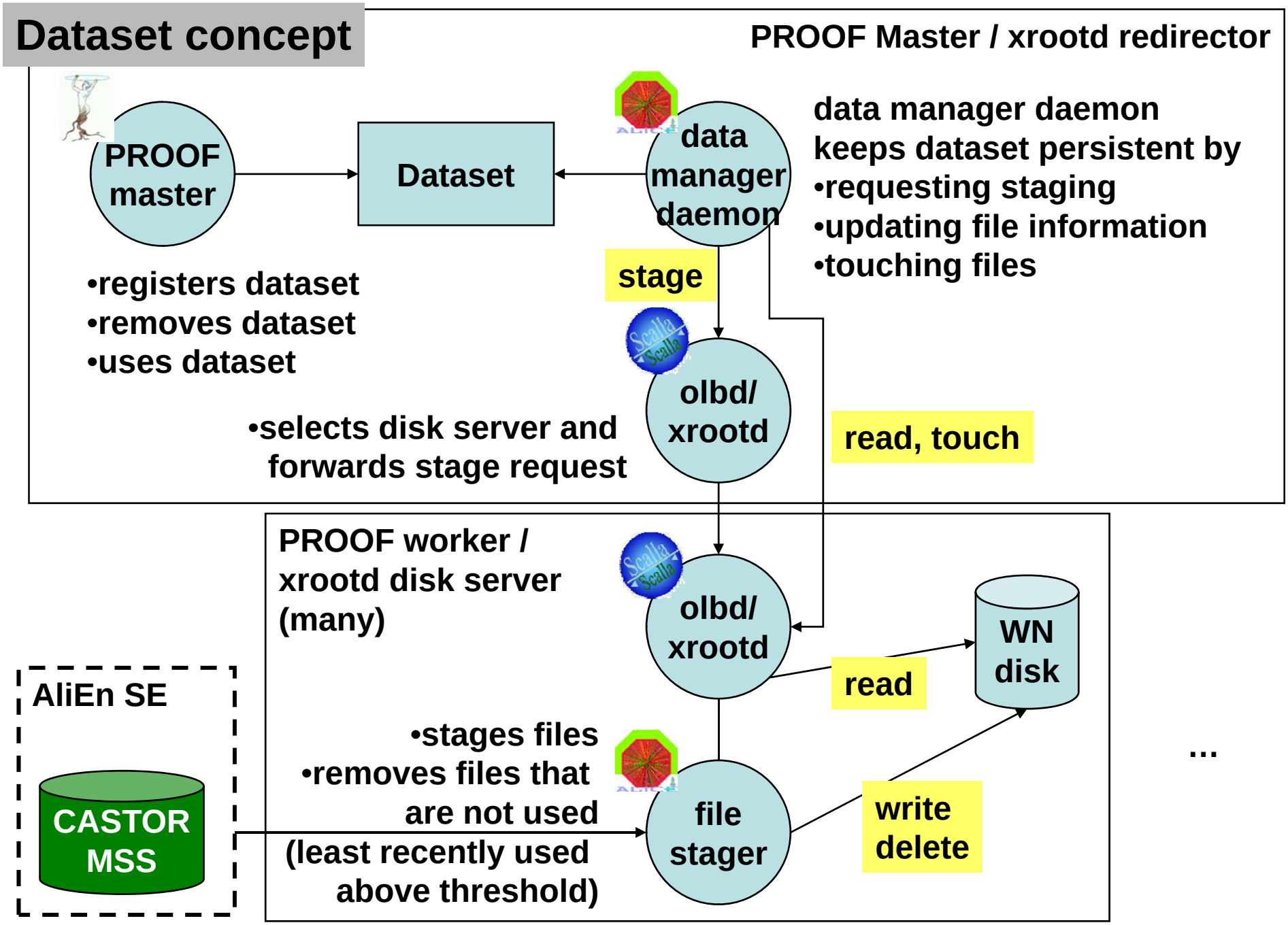
- Currently: semi-automatic
  - Staging of each single file has to be requested (can be done by the user)
  - xrootd + staging script used to select the staging disk server and actually stage the file
  - Available files communicated by text files containing list of files
  - 30K files distributed (MC) = 3M pp events, total size ~ 1.5 TB
- Under development by ALICE + PROOF team: Dataset concept (see next slides)

PROOF Dataset Features

- A dataset represents a list of files (e.g. physics run X)
  - Correspondence between AliEn dataset and PROOF dataset
- Users register datasets
  - The files contained in a dataset are automatically staged from AliEn/CASTOR (and kept available)
  - Datasets are used for processing with PROOF
    - Contain all relevant information to start processing (location of files, abstract description of content of files)
- File-level storing by underlying xrootd infrastructure
- Files available in several datasets to be staged only once
- Quota-enabled
- Datasets are public for reading
- Global datasets

More details on AliEn:
P. Saiz [443], Mo, 15:20

Dataset concept



Dataset in Practice

- Create DS from AliEn collection
  - ds = TGridResult::GetFileCollection()
- Upload to PROOF cluster
  - gProof->UploadDataSet("myDS", ds)
- Check status: gProof->ShowDataSet("myDS")
  - TFileCollection myDS contains: 1000 files with a size of 53758817272 bytes, 100.0 % staged
    The files contain the following trees:
    Tree /esdTree: 100000 events
    Tree /HLTesdTree: 100000 events
- Use it: gProof->Process("myDS", "mySelector.cxx")

Groups & Quotas

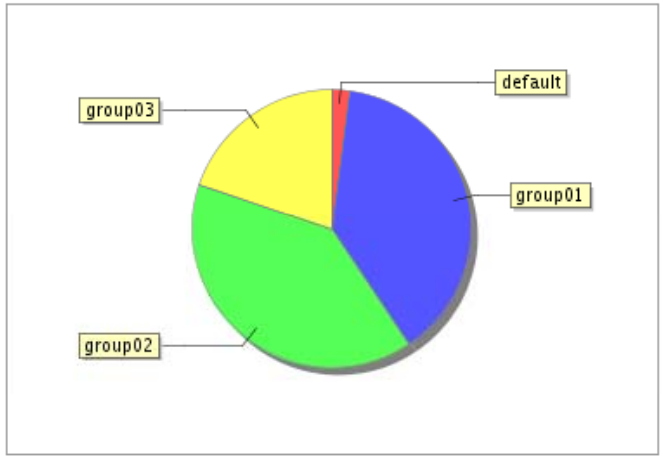
- Users are grouped
  - E.g. sub detectors or physics working groups
  - Users can be in several groups
- Quotas on disk usage and targets for CPU fair-share (both under development) are enforced on group level
- How to introduce and obtain feedback about the system from ALICE's users?
  - Monthly tutorials at CERN (180 users followed so far)
  - Data challenge data **only** available via PROOF and AliEn Grid

Monitoring with MonALISA

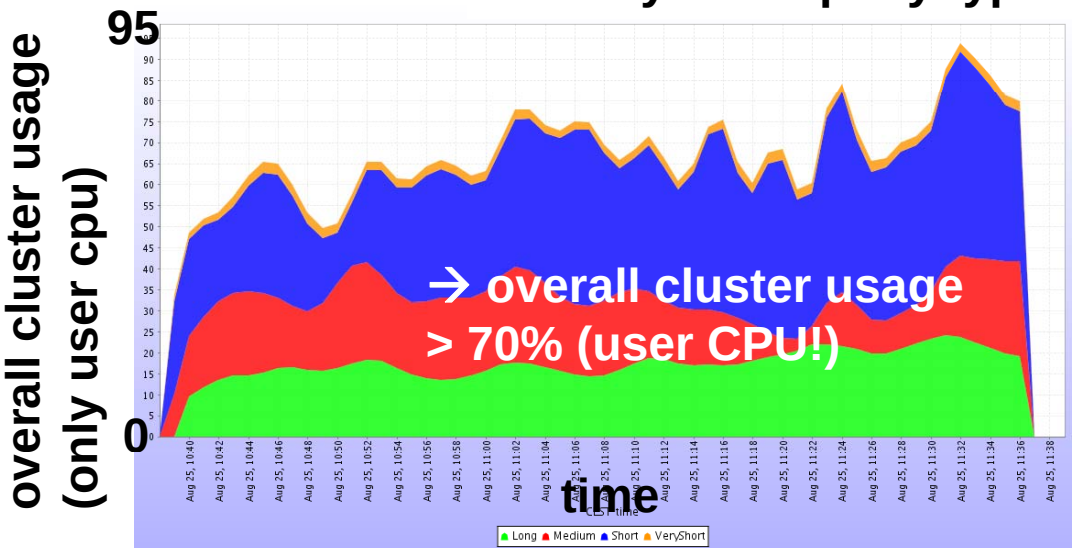
- Cluster (machine-level) with ApMon
- Query statistics
  - Sent at end of each query
- CPU quotas: Consolidation done by ML
- Disk quotas: Visualized by ML

Watch live:
pcalimonitor.cern.ch
“CAF monitoring”

CPU per group



Aggregation plot of CPU used by each query type



ALICE's software framework

- AliRoot is based on ROOT: ROOT + set of libraries = AliRoot
- AliRoot on shared space (AFS), libraries loaded after connecting to the PROOF cluster (few lines macro)
  → "converts" ROOT running on PROOF worker into AliRoot
- Case 1: End-user analysis, Comparison to MC
  - Only a few small libraries are needed (ESD, AOD)
- Case 2: Detector debugging, calibration, alignment
  - Full framework needed (access to raw data, clusters, …)
- Optional user (Physics working group) libraries
  - Distributed as PROOF packages (par files)
- Wrapper classes (inherit TSelector) enabling access to ALICE's data structures available for both cases
- Integrated with ALICE's analysis task framework (based on TTask)

Details on AliRoot:
F. Carminati [446]
Mo, 14:00

Outlook

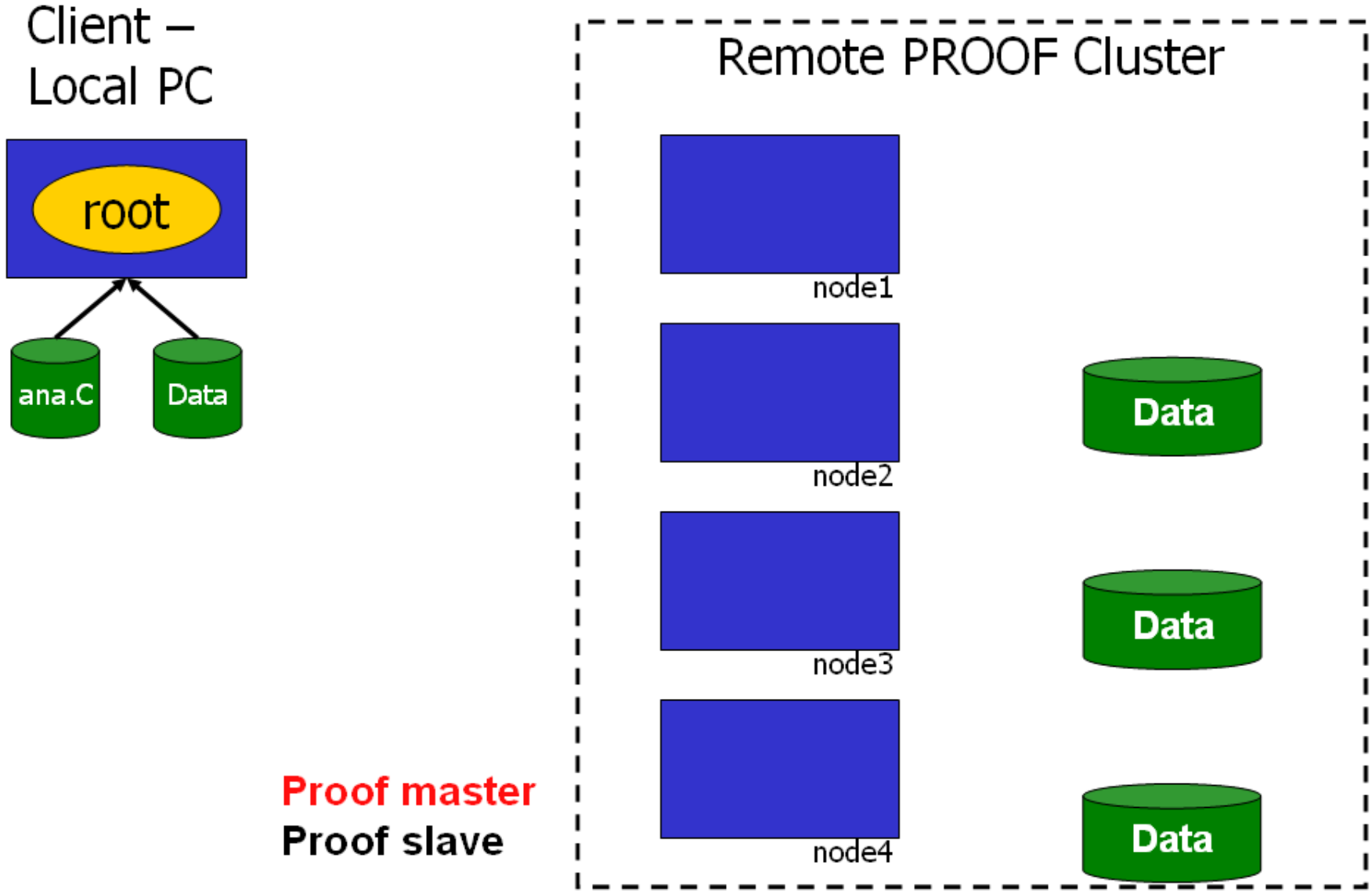
- Finalize datasets & CPU fairshare system
  - Benchmark staging
- Increase cluster size
- Exercise data processing during the full dress rehearsal & cosmic data taking (Oct '07/Feb '08)

Summary

- ALICE uses PROOF on a cluster called CERN Analysis Facility. It will allow prompt and pilot analysis, calibration/alignment, fast simulation and reconstruction → Fast response time
  - ALICE computing model only foresees a CAF at CERN, maybe also good solution for other centers?!
- A test setup is in place since May 2006
  - Users are trained in tutorials and use the system for "analysis"
- Active collaboration with ROOT team
  - Contribution from ALICE to PROOF development
  - Dataset concept and CPU quotas implemented and under test
- ALICE's data processing will benefit and benefits already now from such a system

Backup

PROOF Schema



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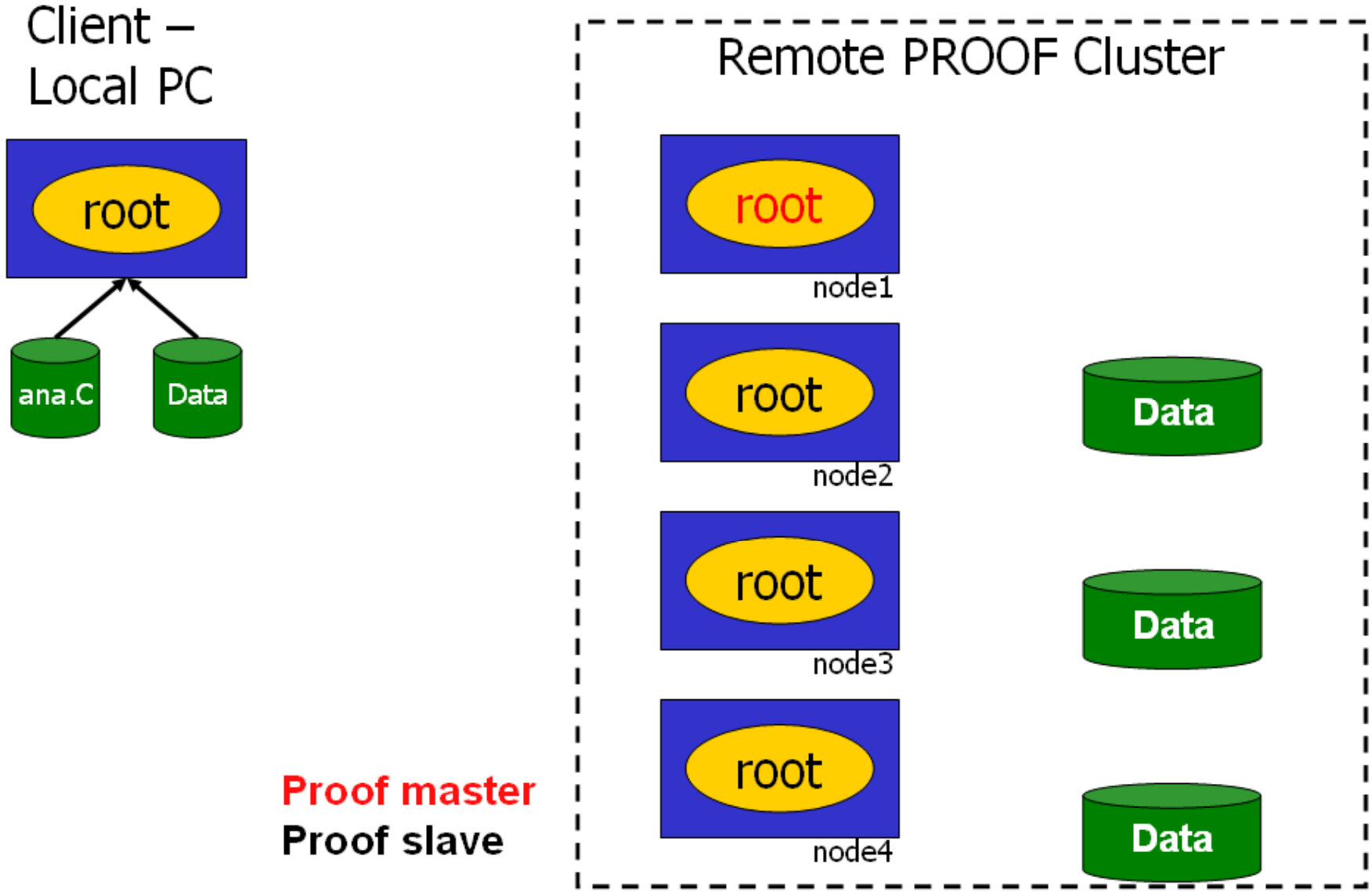

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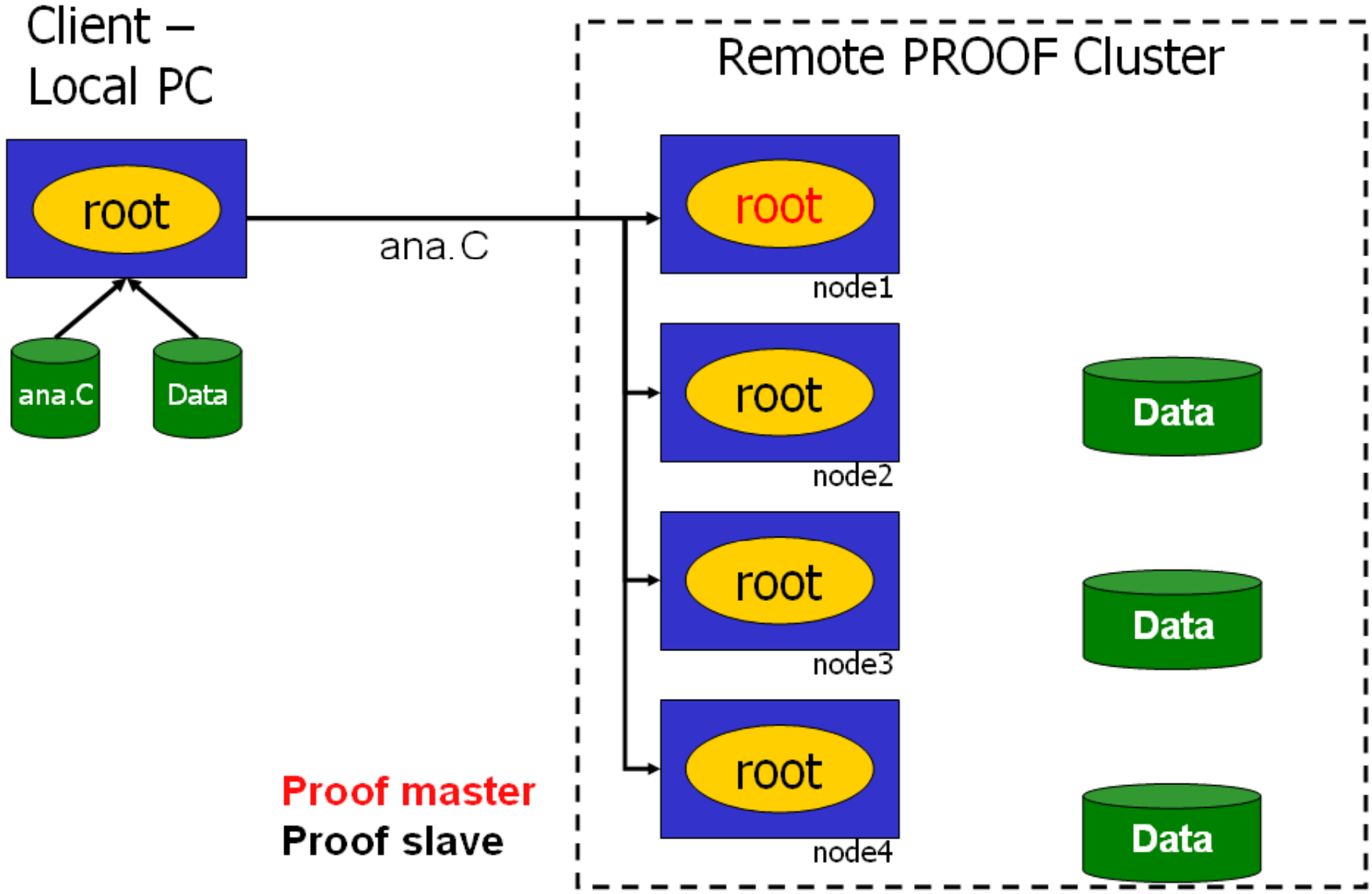

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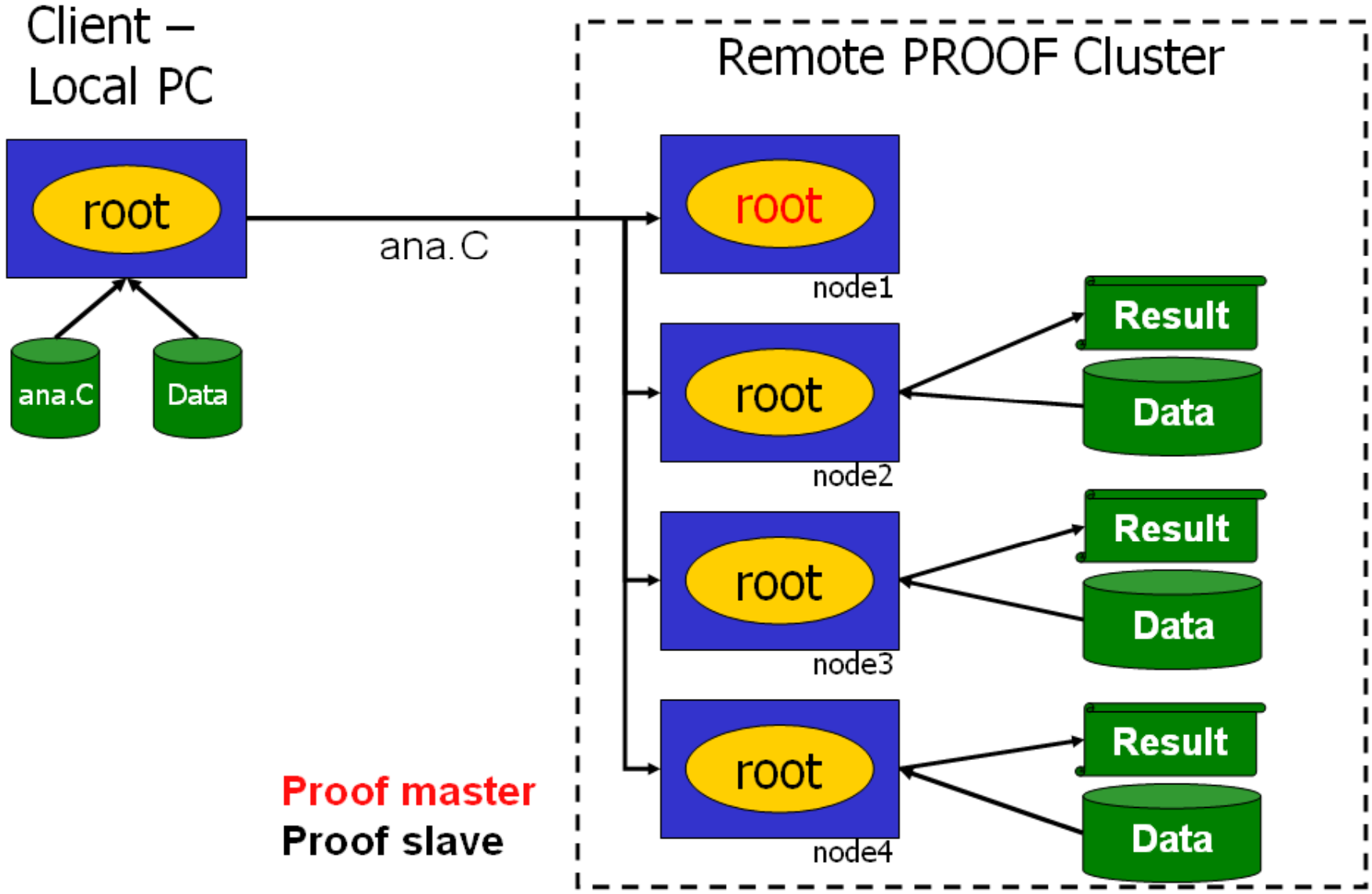

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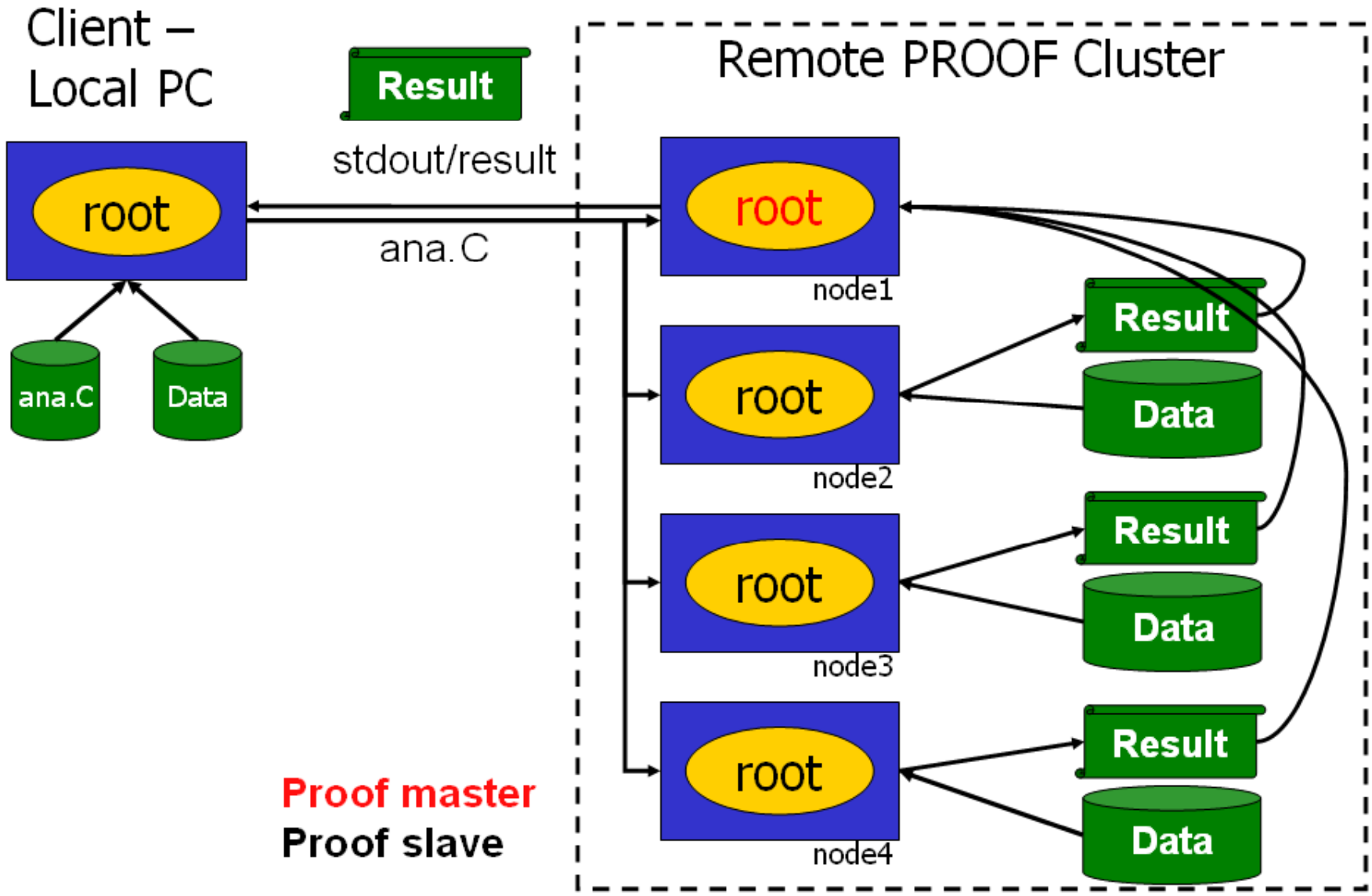

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Dataset concept