Analisi di Immagini Mediche Distribuite

Il progetto MAGIC-V*

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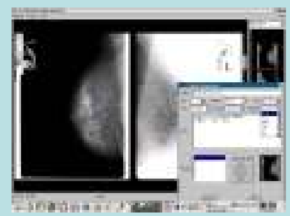
*** INFN: Ba, Ca (Ss), Ge, Le, Na, Pi, To**
University: Ba, Ge, Le, Na, Pa, PO, Pi, Ss, To

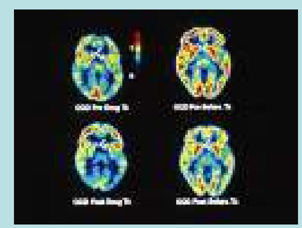
MAGIC-V

Computer Assisted Detection (CAD) & **Distributed Computing Infrastructure (GRID)**

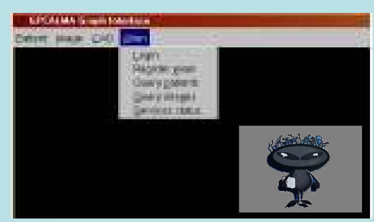
- Medical (Imaging) Applications



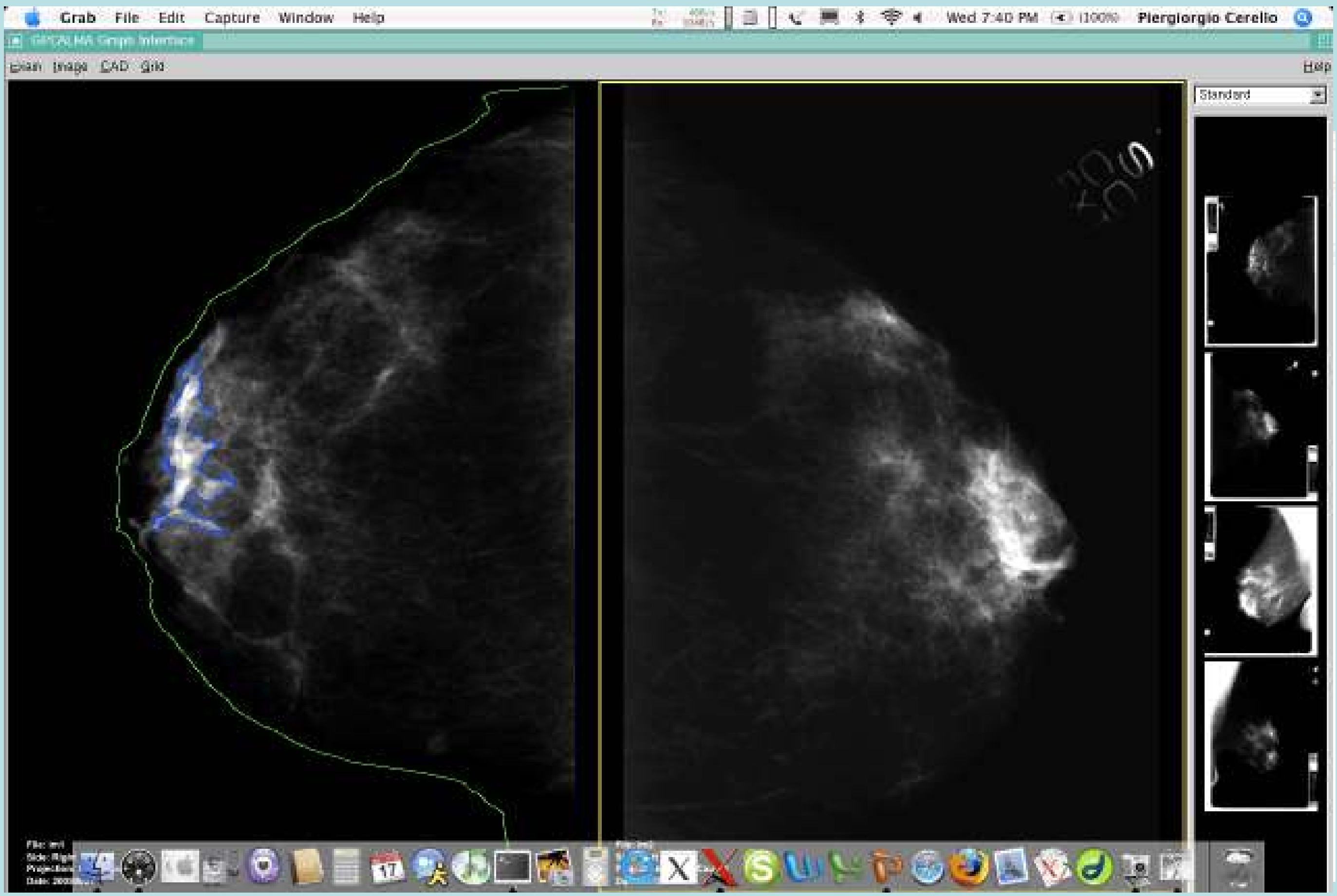
  - Analysis of Digital Images
    - **Mammography**
    - **Lung CTs**
    - **Brain MRIs**



- GRID
  - Why Medical ***Imaging*** Applications?
  - Grid use cases: (mammographic) screening
  - Interface to GRID Services

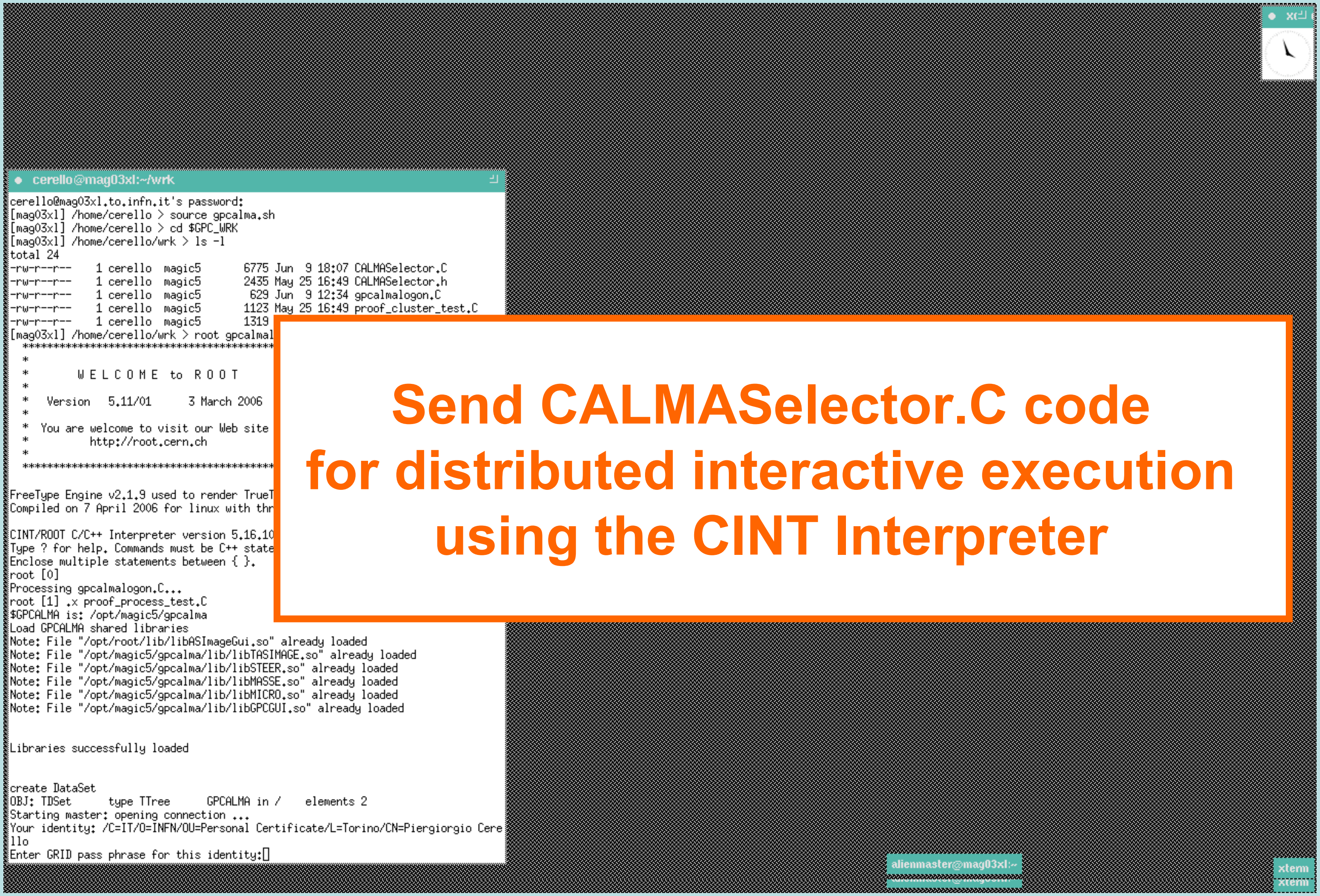


Analysis Station



The GPCALMA Mammogram Analysis Station

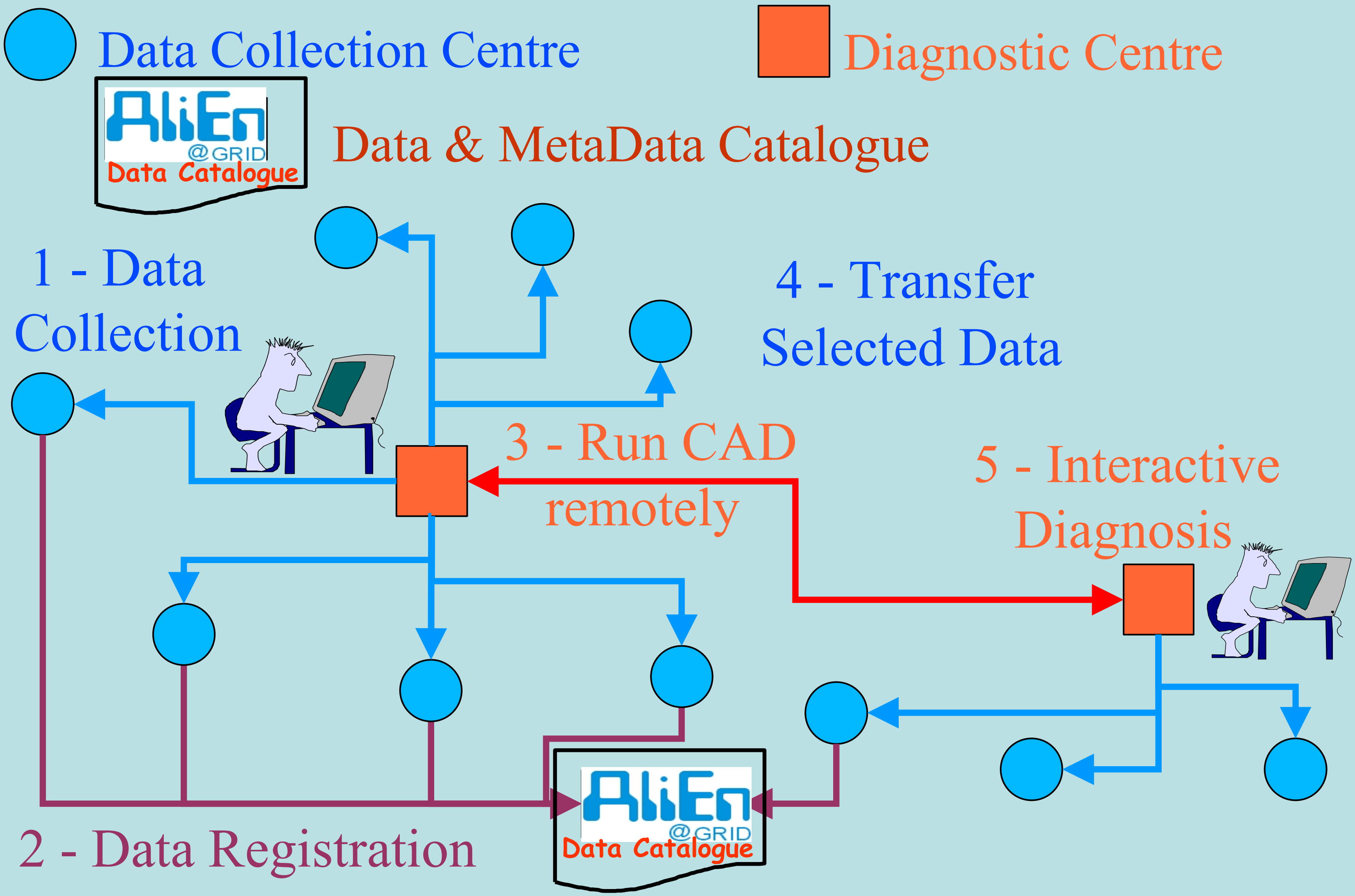
PROOF Cluster - End of Task
for interactive distributed analysis
Display (or Save) Results



Send CALMASelector.C code for distributed interactive execution using the CINT Interpreter

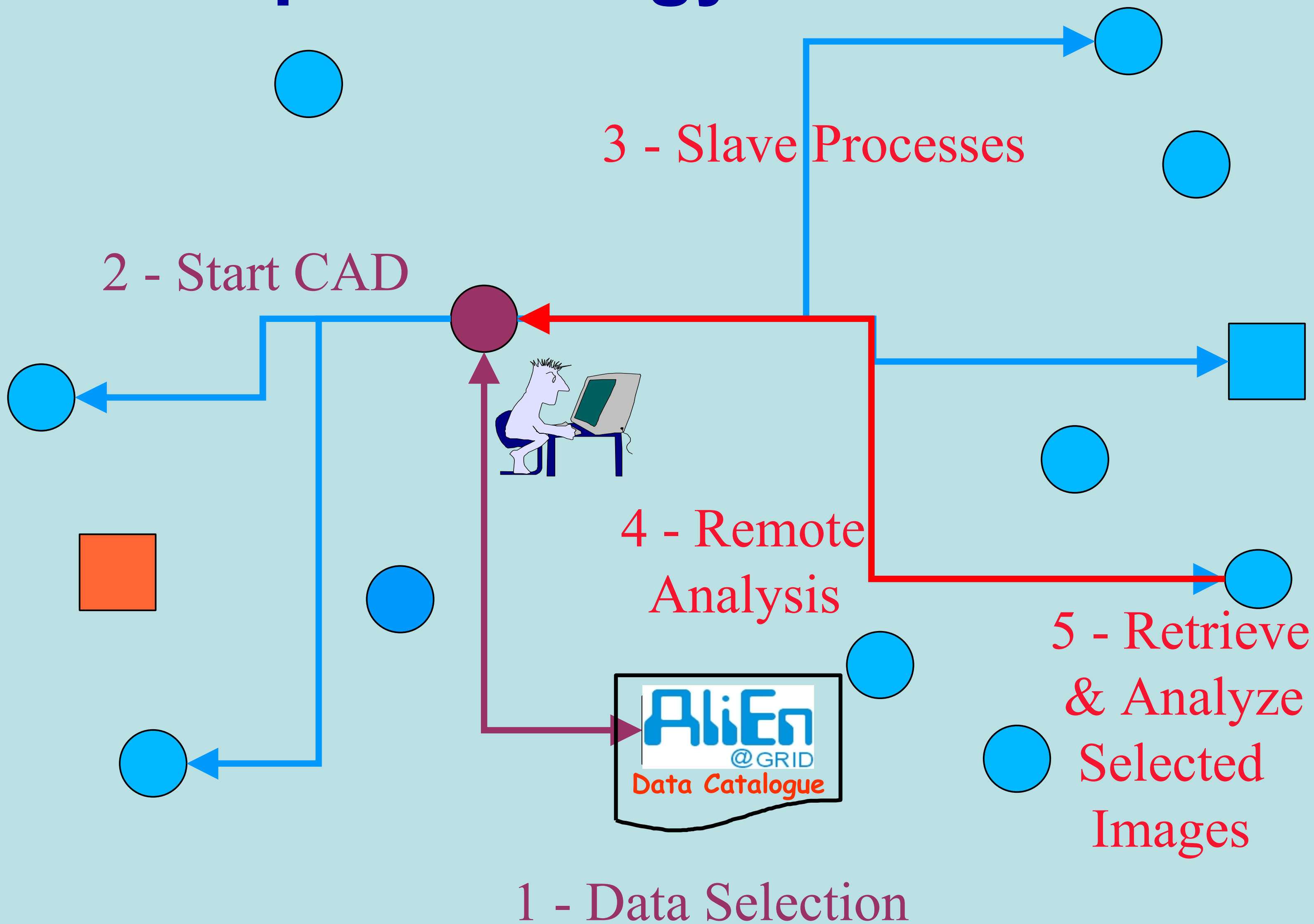
The GPCALMA Mammogram Analysis Station

GPCALMA Screening Use Case



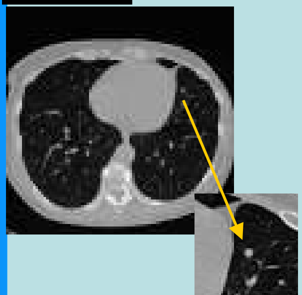
CAD selection to minimize data transfers

GPCALMA Tele-training & Epidemiology Use Case

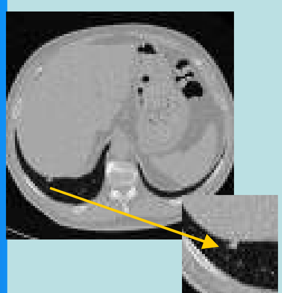


Lung CT Analysis

n 1



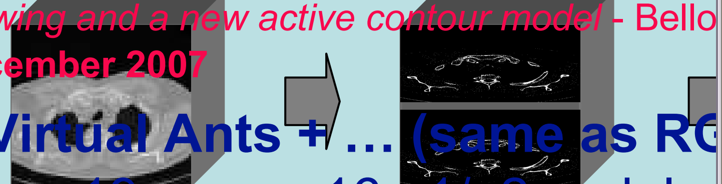
n 2



n 3

- **Problem: the large number of false positives**
- Strategy: many approaches with 100% sensitivity (S) in **logical AND**
- **Segmentation: find the lung volume**
- **Pleural nodules**
  - 42 scans with 102 nodules:
- **Dot-Enhancement (D-E)**
  - 24 scans with 45 n1 nodule
- **Region Growing + Linear Filte Forward NN on Area, Sphericit**
  - 19 scans with 26 (15n1 + 1

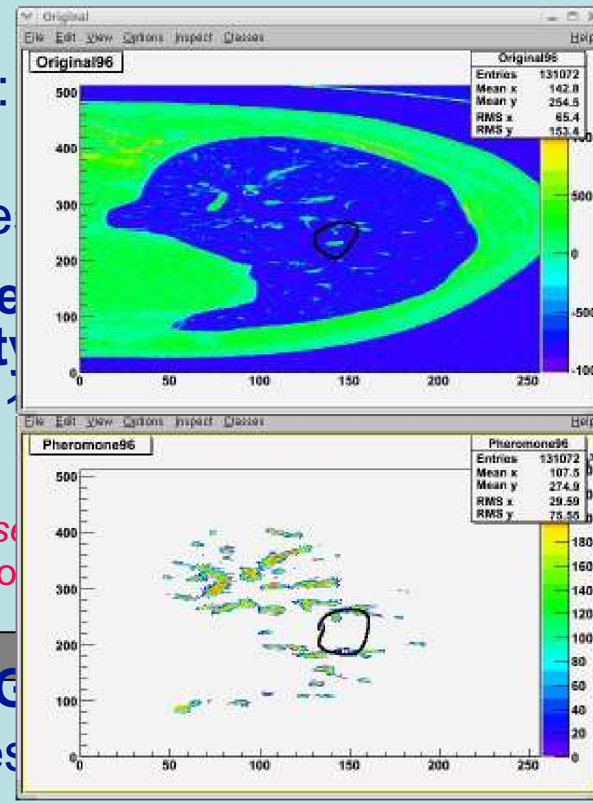
  with about **6.6 FP/scan***



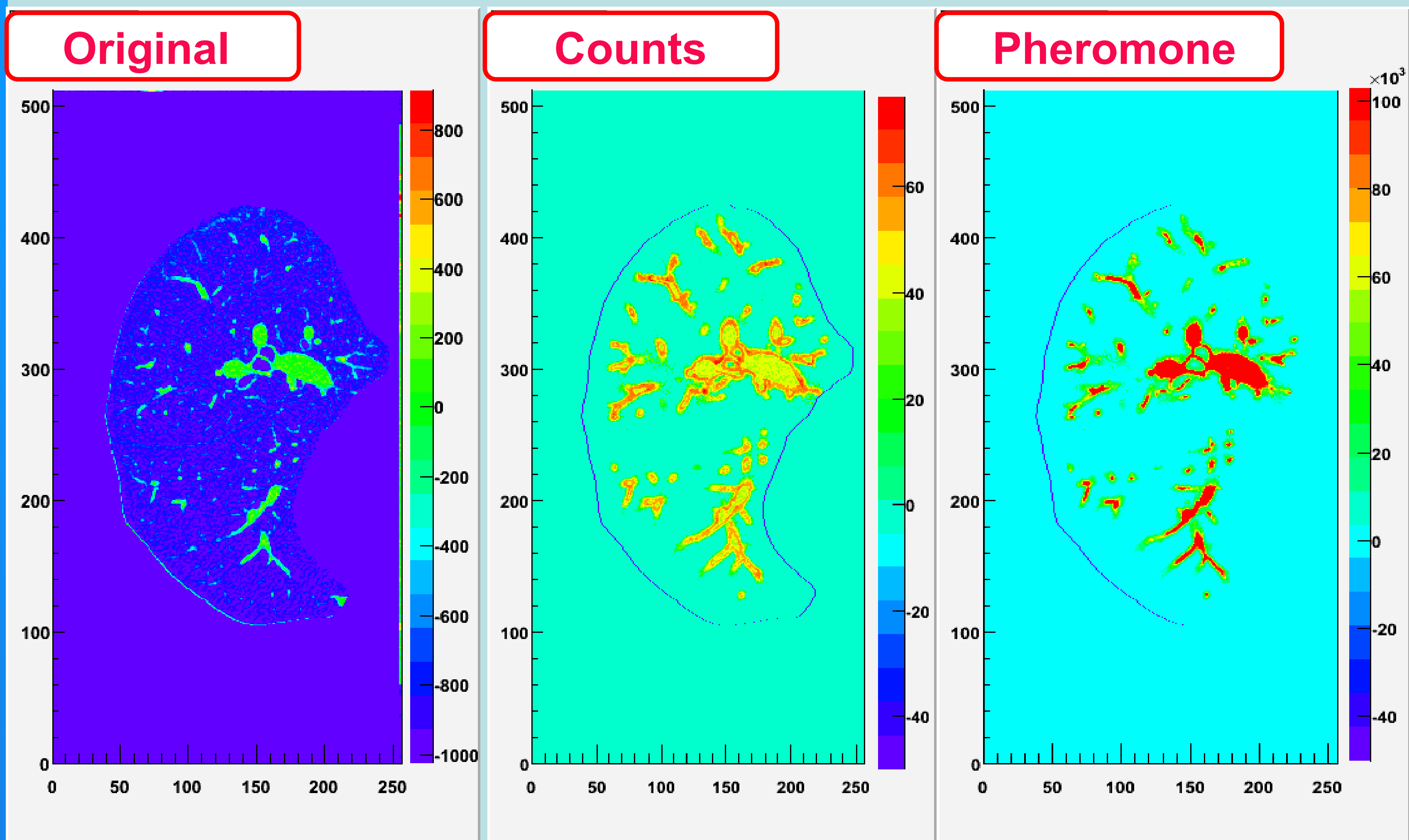
**A CAD system for nodule detection in low-dose growing and a new active contour model* - Bello
December 2007

- **Virtual Ants + … (same as RG**
  - 19 scans, 16 n1/n2 nodules
  - **on D-E output**

300 --> 16 FP/scan before classification!!!!



Virtual Ants in a lung CT



Alzheimer’s Disease

“…there is no definitive Alzheimer’s Disease Diagnosis other than a brain biopsy or autopsy…”

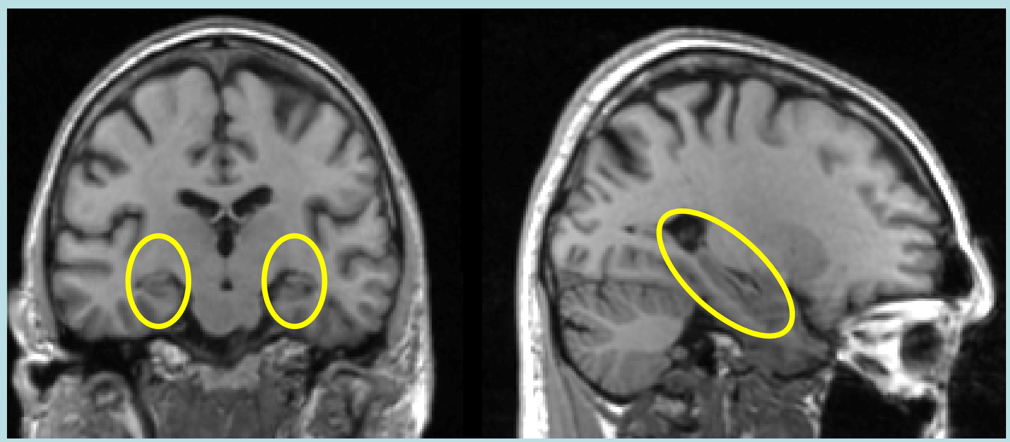
input from…

- **Clinical history, Cognitive tests**
- **CSF protein fraction dosage**
- **Functional images (PET/SPECT)**
- **Anatomical parameters (MRI)**

MRI:

- brain atrophy (mainly gray matter replaced by liquid)

- hyppocampus shape analysis

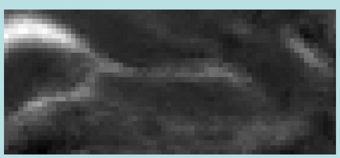


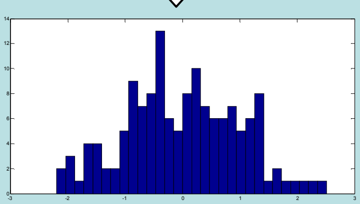
Alzheimer’s Disease

Unsupervised Hippocampus Segmentation and Classification

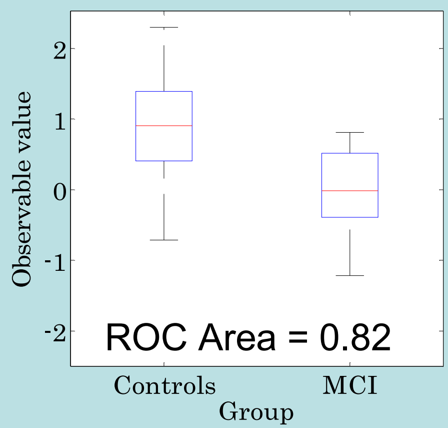
Cerebral matter distribution around the hippocampus

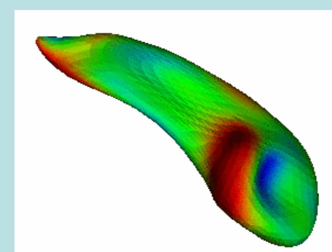
Hippocampus shape analysis





Observable statistics



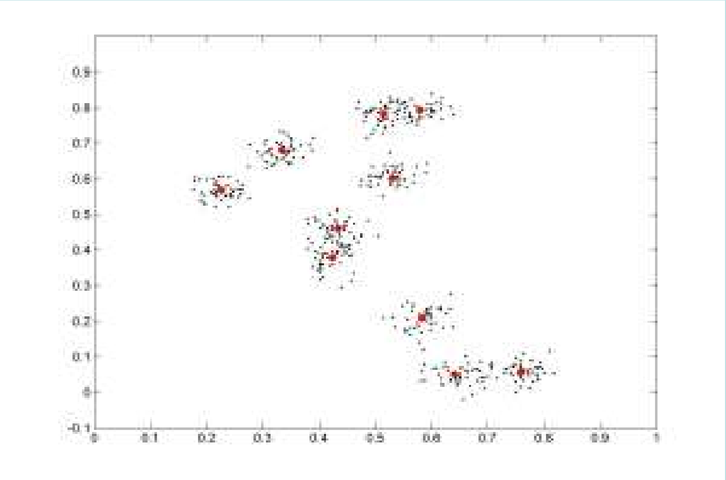


Metric and spherical harmonics analysis

<u>Clinical validation is in progress</u>

Alzheimer’s Disease

Alternative method for Gray Matter distribution study:
Artificial Neural Networks



Simulated Data-points:
10^3 x Real Data-points, with Normal distribution around the Real Data

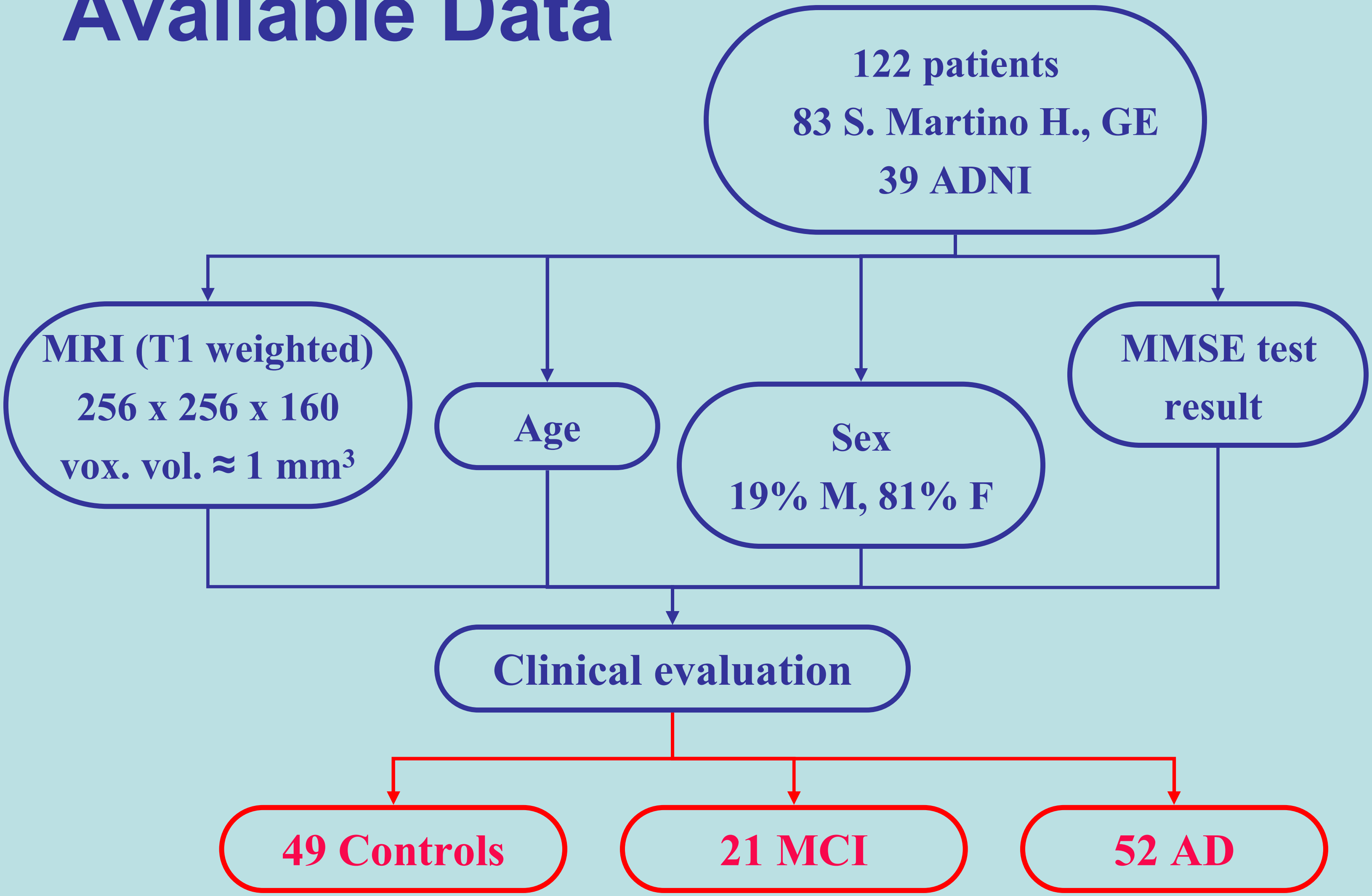
Validation:
- **blind classification**
- **stable and consistent results**
- **cross check of the MCI classification results with clinical data**

Preliminary

REAL DATA	SIMULATED DATA	
Neural Network	Neural Network	Logistic Regression
0.812 ± 0.045	0.731 ± 0.052	0.808 ± 0.044

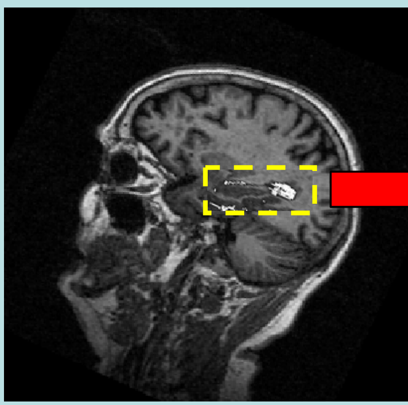
Alzheimer's Disease

Available Data



Alzheimer's Disease

Hippocampus Segmentation



K-means

f_1

f_2

f_3

f_4

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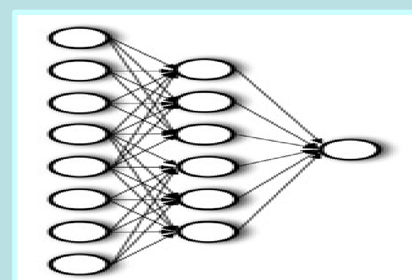
.
.
.
.

f_{24}

Logistic Regression



Alzheimer's Disease

Preliminary Results

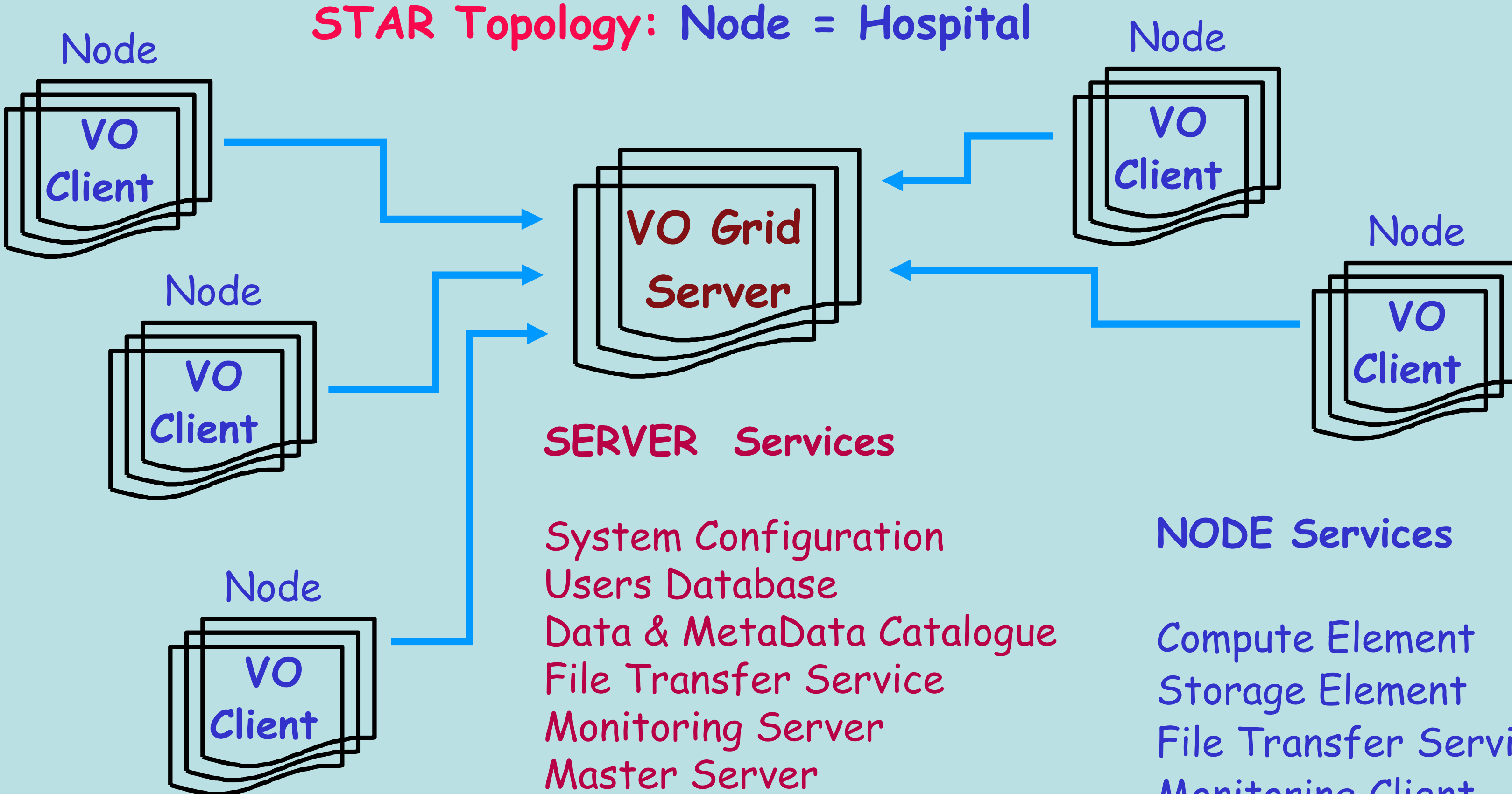
Classifier	Training Data	AUC±σ	Sensitivity	Sensitivity
Logistic Regression	Real 24 features	--	0.69±0.03	0.71±0.03
Logistic Regression	Sintetic 24 features	0.81±0.002	0.74±0.03	0.70±0.03
Neural Network	Real 24 features	0.81±0.004	0.71±0.03	0.71±0.03
Neural Network	Sintetic 24 features	--	0.71±0.03	0.71±0.03
Logistic Regression	Real 16 features	--	0.72±0.03	0.71±0.03
Logistic Regression	Sintetic 16 features	0.85±0.01	0.84±0.03	0.71±0.03
Neural Network	Real 16 features	0.76±0.01	0.70±0.03	0.71±0.03
Neural Network	Sintetic 16 features	--	0.74±0.03	0.71±0.03

MAGIC-V, where are we?

- **Mammogram Analysis Station**
  - installed in some hospitals in Italy and the Suzanne Mubarak Centre in Alexandria, Egypt
  - Ongoing validation on digitised data
  - Collection of a digital DB started with ASL2, Perugia, ASL1, Torino
- **Lung CAD development**
  - Several approaches developed, very promising results
  - DB being extended for further validation
- **Neuroimages Analysis**
  - Activity started in 2007, some preliminary results already available
- **GRID prototypes**
  - Prototype implemented for mammogram distributed analysis
  - Further developments related to the possible implementation in a real large scale use case

What kind of Deployment?

STAR Topology: Node = Hospital



SERVER Services

System Configuration
Users Database
Data & MetaData Catalogue
File Transfer Service
Monitoring Server
Master Server
Distributed cluster access
Other…

NODE Services

Compute Element
Storage Element
File Transfer Service
Monitoring Client
Worker Client
Application

What kind of Deployment?

TIER Topology: Node = Hospital, Site = Computer Centre

NODE Services
- Worker Client
- Application

SITE Services
- Compute Element
- Storage Element
- File Transfer Service
- Monitoring Client