

NeuroLOG

ANR TechLog 2007-2009

Software technologies for integration of process, data and knowledge in medical imaging.

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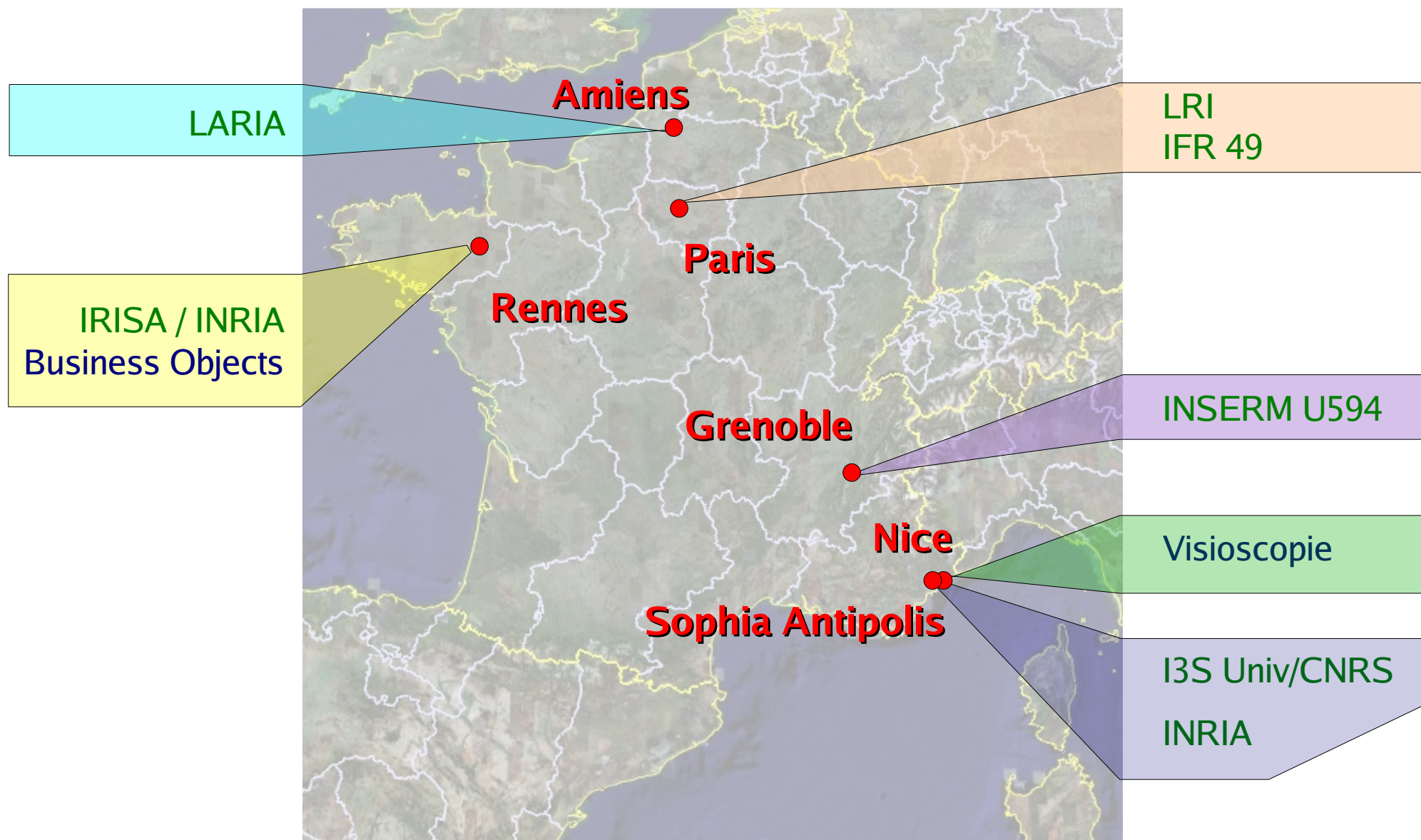


French national project

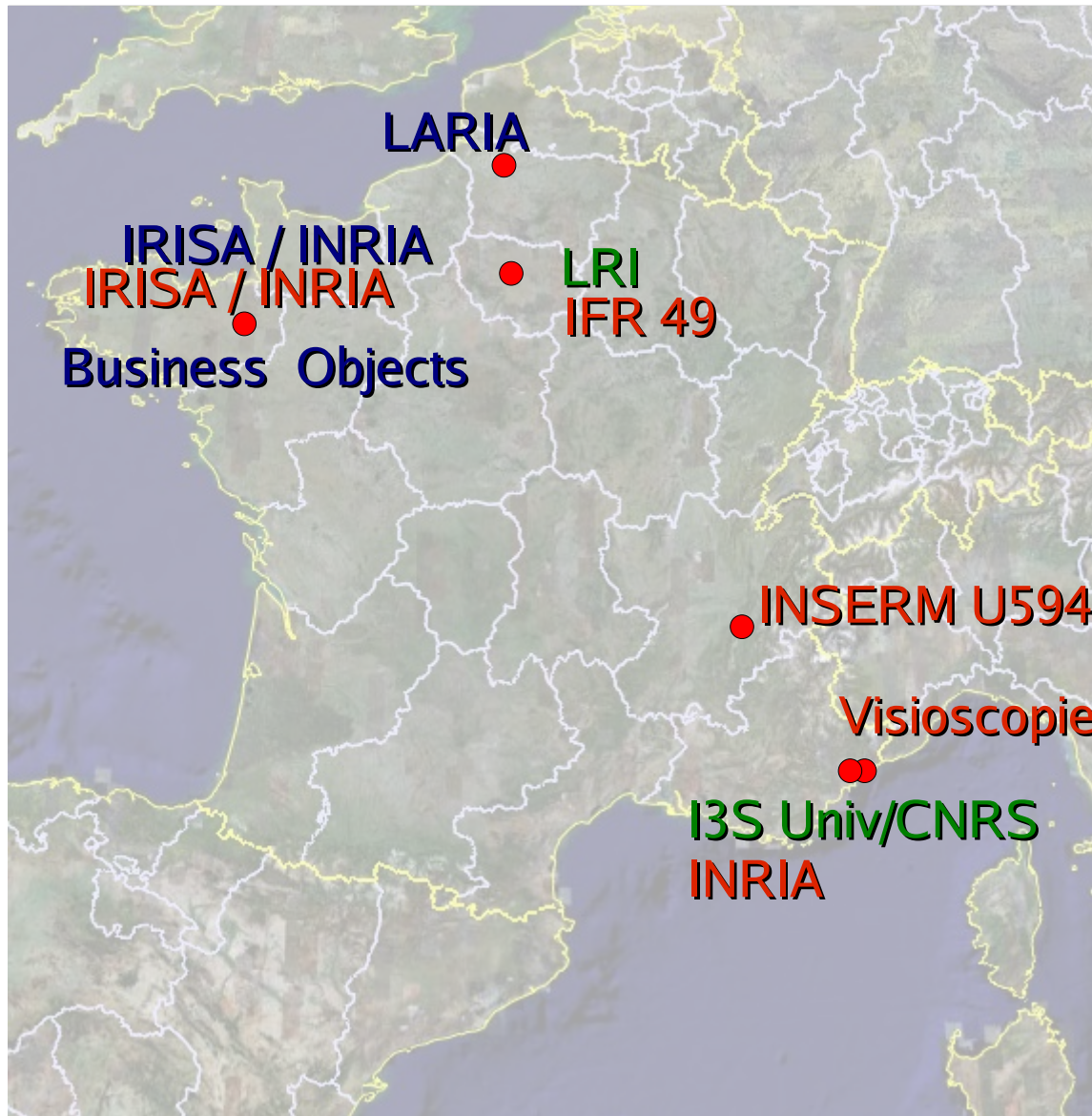


Partners:

Research labs and Companies



A multidisciplinary project



software technologies

databases and knowledge

medical imaging

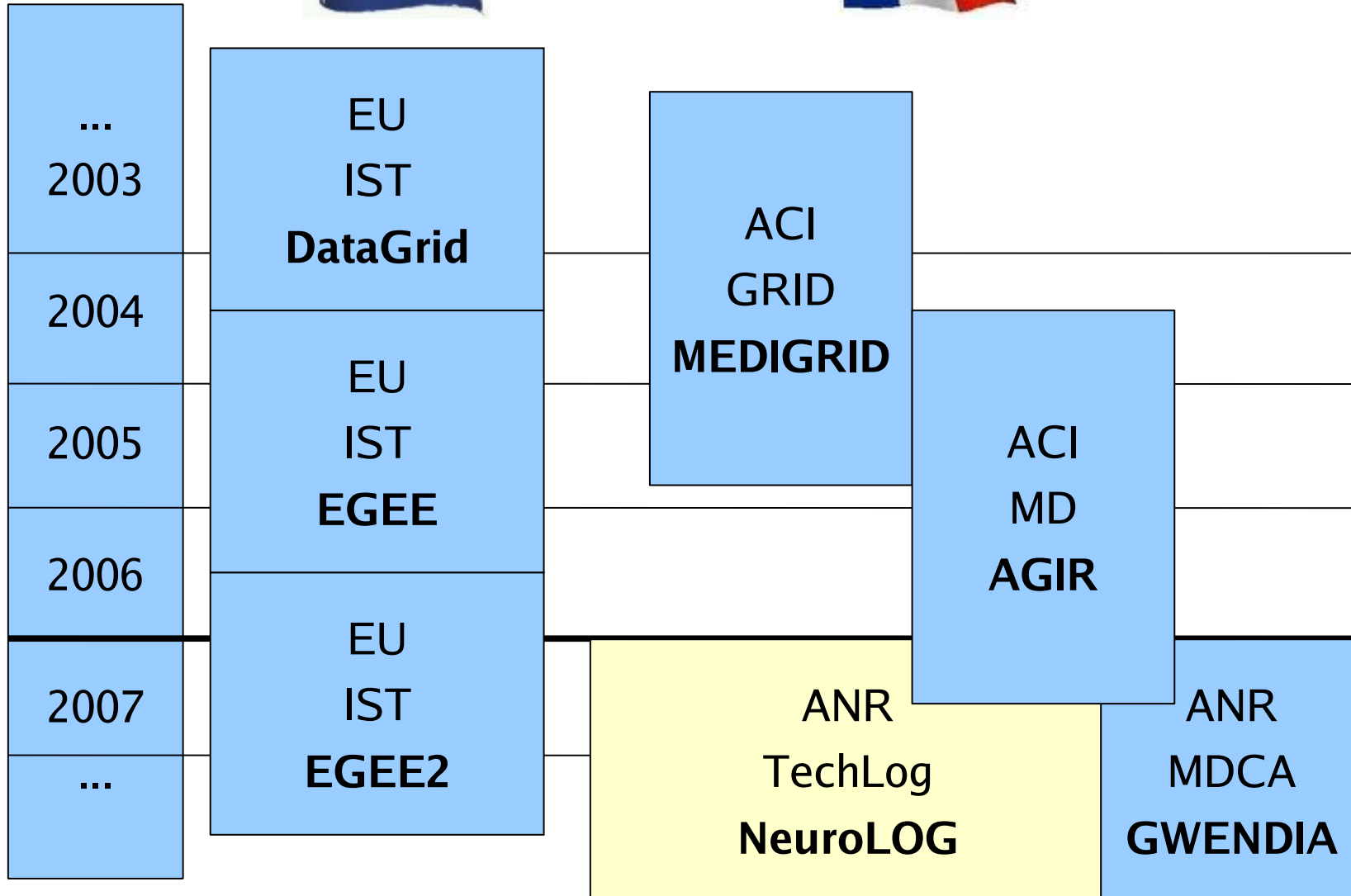
We want to address:

- ▶ Management and access of partly structured data, heterogeneous and distributed in an open environment.
- ▶ Access control and protection of private medical data.
- ▶ Control of workflows implied in complex computing process on grid infrastructures.
- ▶ Extraction and quantification of relevant parameters for different pathologies:
 - Multiple sclerosis
 - Brain Vascular Stroke
 - Brain tumors

“TechLOG” grant

- ▶ In between:
 - Fundamental research
 - Industrial/Clinical application
- ▶ Previous works
 - Medigrid – medical image management on a grid
 - AGIR – grid services for radiological data analysis
 - DataGrid / EGEE – pan-European grid infrastructure

Grants



Tools

- ▶ **MDM** (Medical Data Management)
<http://www.aci-agir.org/mdm.html>
- ▶ **LeSelect** (Enabling the federation of heterogeneous data sources)
- ▶ **MOTEUR** (Optimized workflow enactor for data-intensive grid applications)
<http://www.i3s.unice.fr/~glatard/>
- ▶ **OntoKADS** (ontological approach for the construction of problem-solving models based on CommonKADS)

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MOTEUR

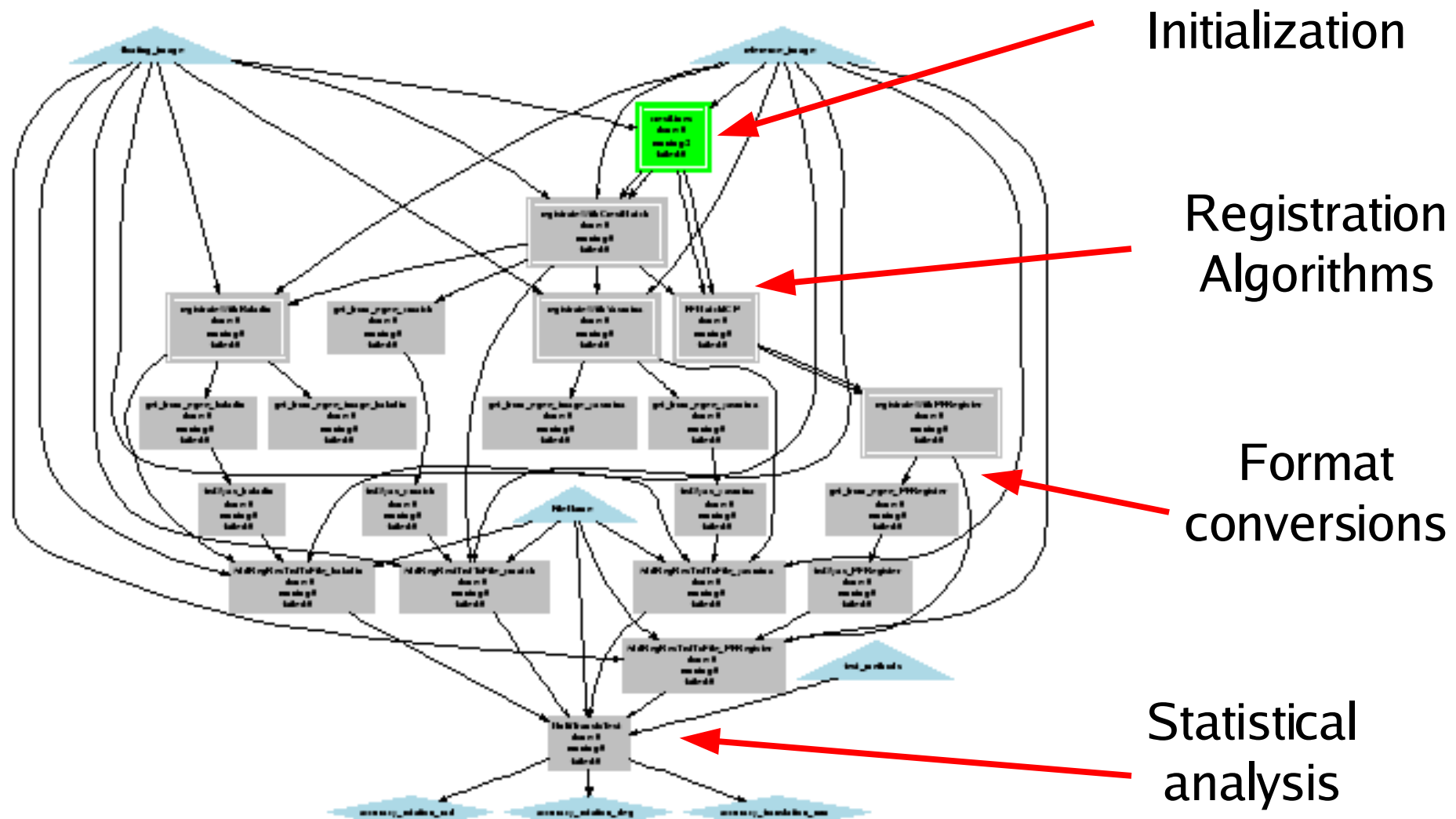
Grid-enabled workflow engine

<http://www.i3s.unice.fr/~glatard>



Application description as a workflow

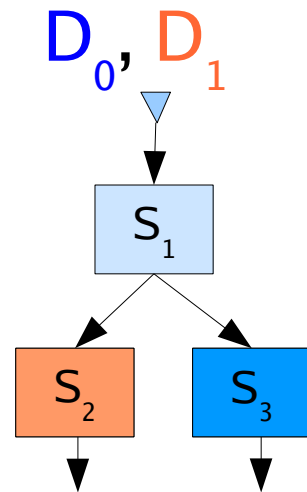
- ▶ Compound application, reusing existing image analysis codes



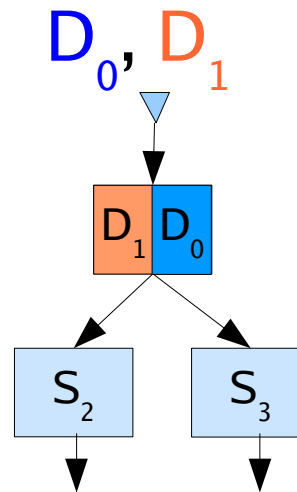
MOTEUR: grid-enabled workflow engine

- ▶ A workflow naturally provides a parallelization of the application
- ▶ Service-based workflows (\neq task-based)
 - Decouples data and processing
- ▶ Transparent exploitation of 3 kinds of parallelism

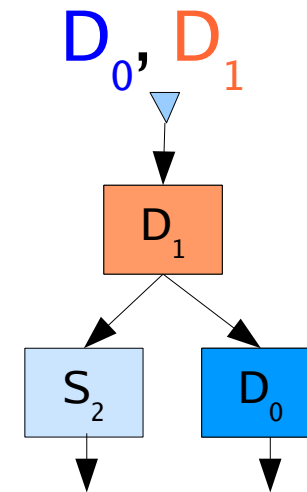
Workflow parallelism



Data parallelism



Service parallelism



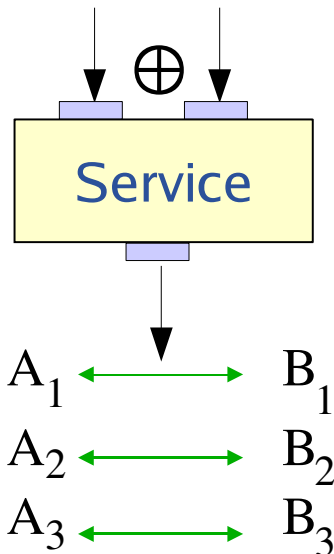
- ▶ MOTEUR workflow manager: <http://www.i3s.unice.fr/~glatard>

Data composition strategies

Data composition patterns: data intensive applications

One-to-one

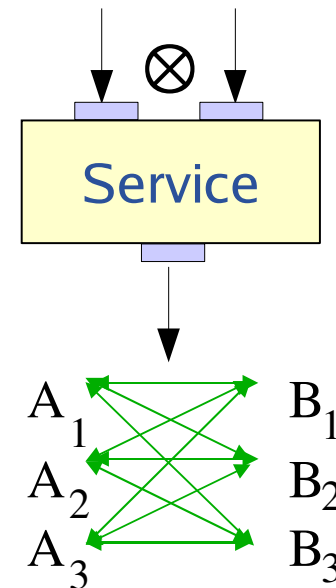
$$\mathbf{A} = \left\{ \begin{array}{cc} A_1 & B_1 \\ A_2 & B_2 \\ A_3 & B_3 \end{array} \right\} = \mathbf{B}$$



$$\mathbf{A} \oplus \mathbf{B} = \{A_1 \oplus B_1, A_2 \oplus B_2, \dots\}$$

All-to-all

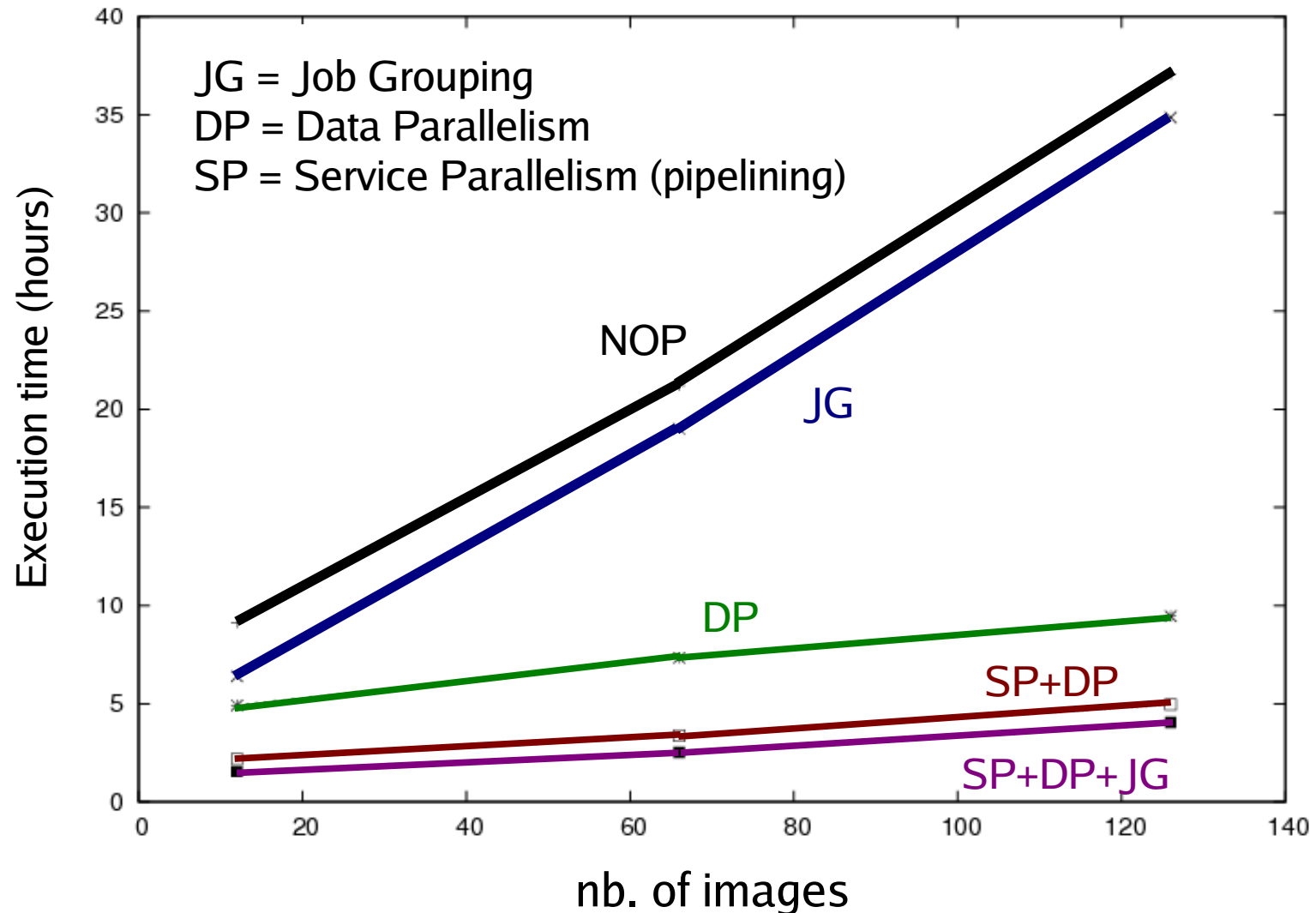
$$\begin{array}{cc} A_1 & B_1 \\ A_2 & B_2 \\ A_3 & B_3 \end{array}$$



$$\mathbf{A} \otimes \mathbf{B} = \{A_1 \otimes B_1, A_1 \otimes B_2 \dots A_1 \otimes B_m, A_2 \otimes B_1 \dots B_m \dots A_n \otimes B_1 \dots A_n \otimes B_m\}$$

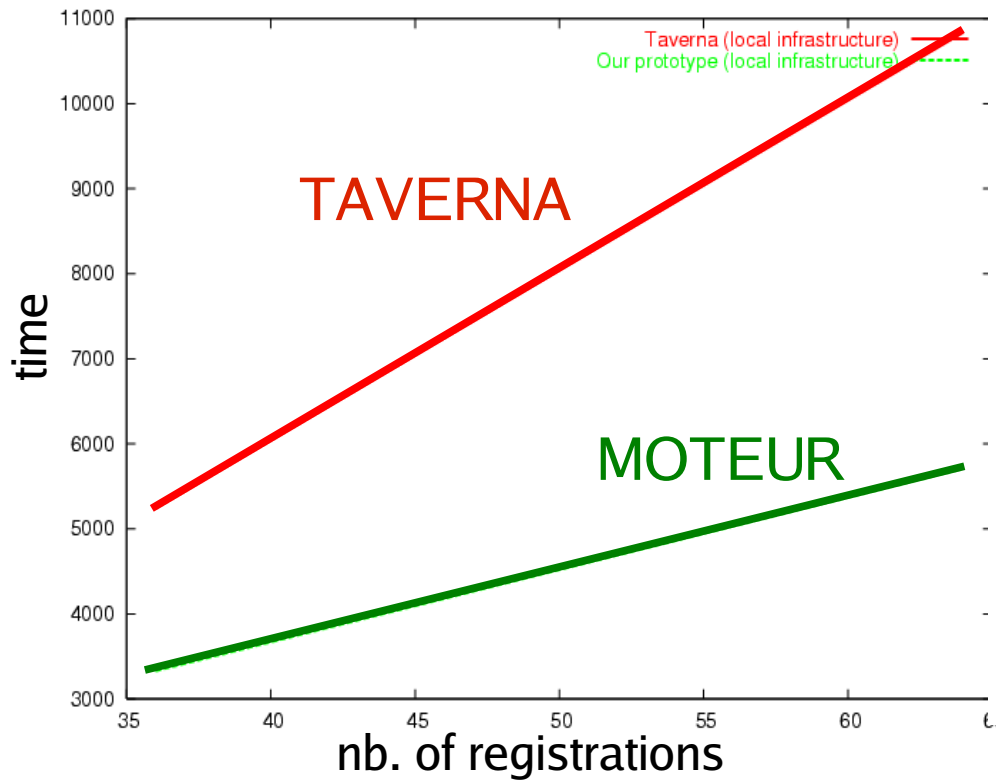
Computational results

- ▶ On the EGEE infrastructure (biomed VO)
- ▶ Impact of the parallelisms:

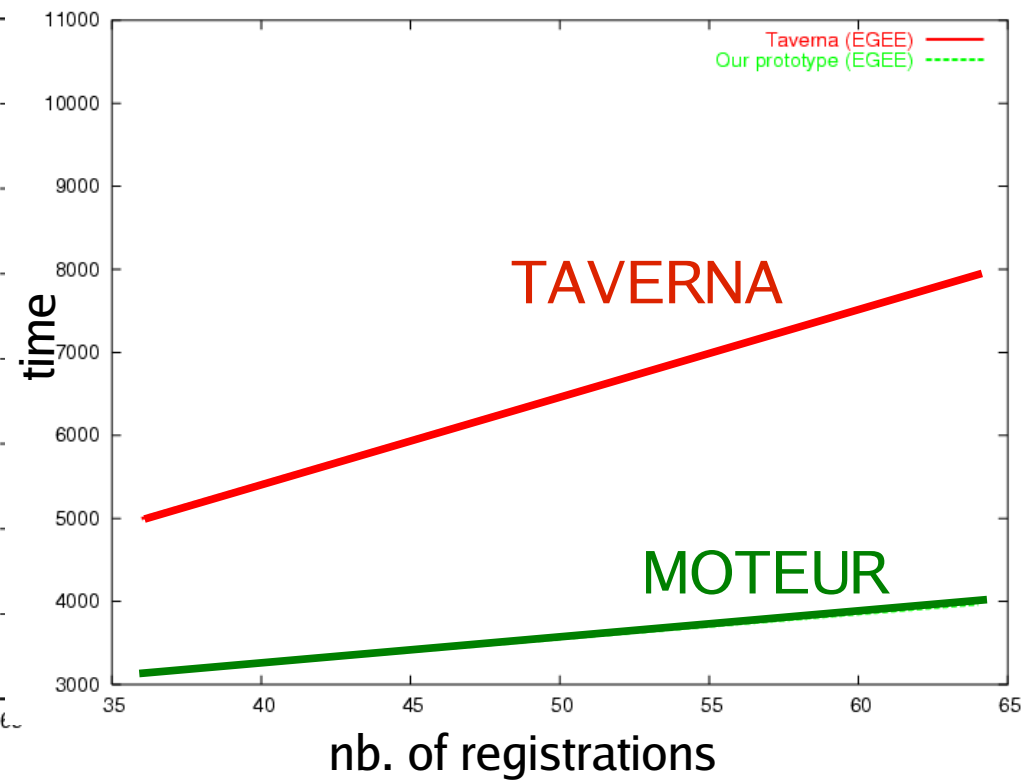


MOTEUR performances

► MOTEUR against Taverna performances



Local execution
(4 computers)



Grid execution



MDM

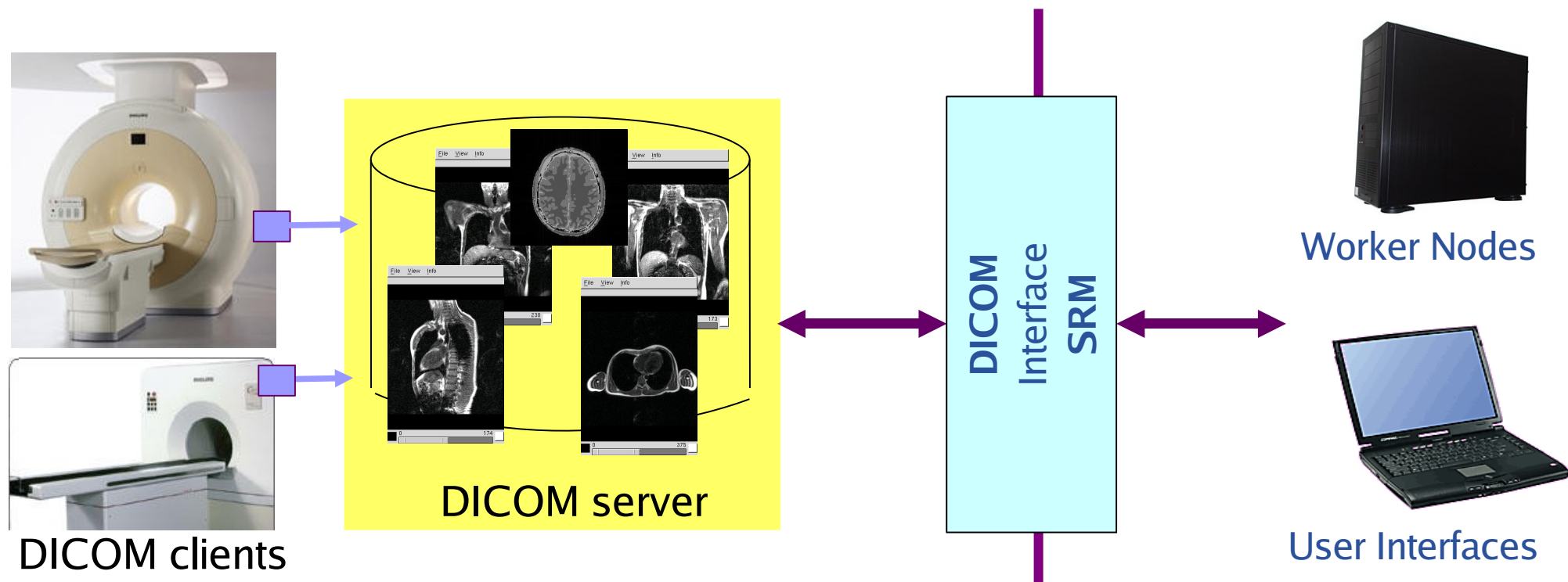
Medical Data Manager



Medical Data Manager

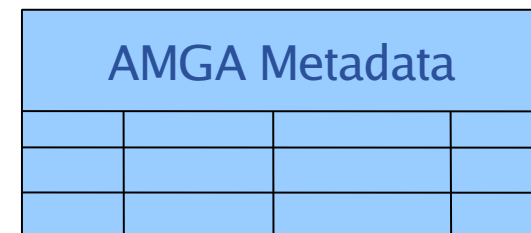
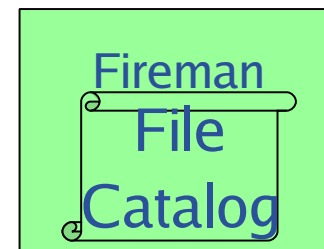
► Objectives

- Expose a standard grid interface (SRM) for medical image servers (DICOM)
- Use native DICOM storage format
- Fulfill medical applications security requirements
- Do not interfere with clinical practice

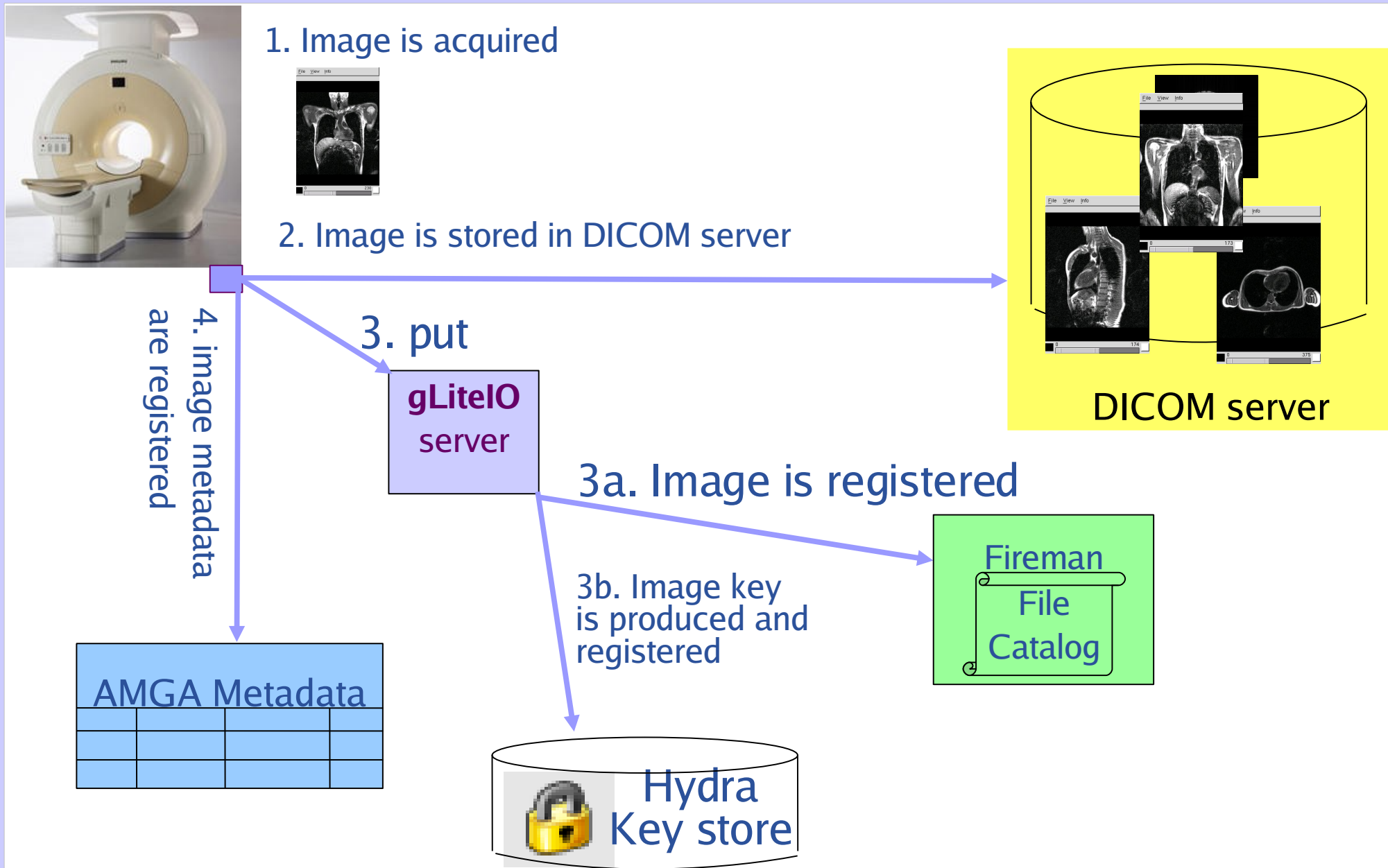


Manipulating sensitive medical data

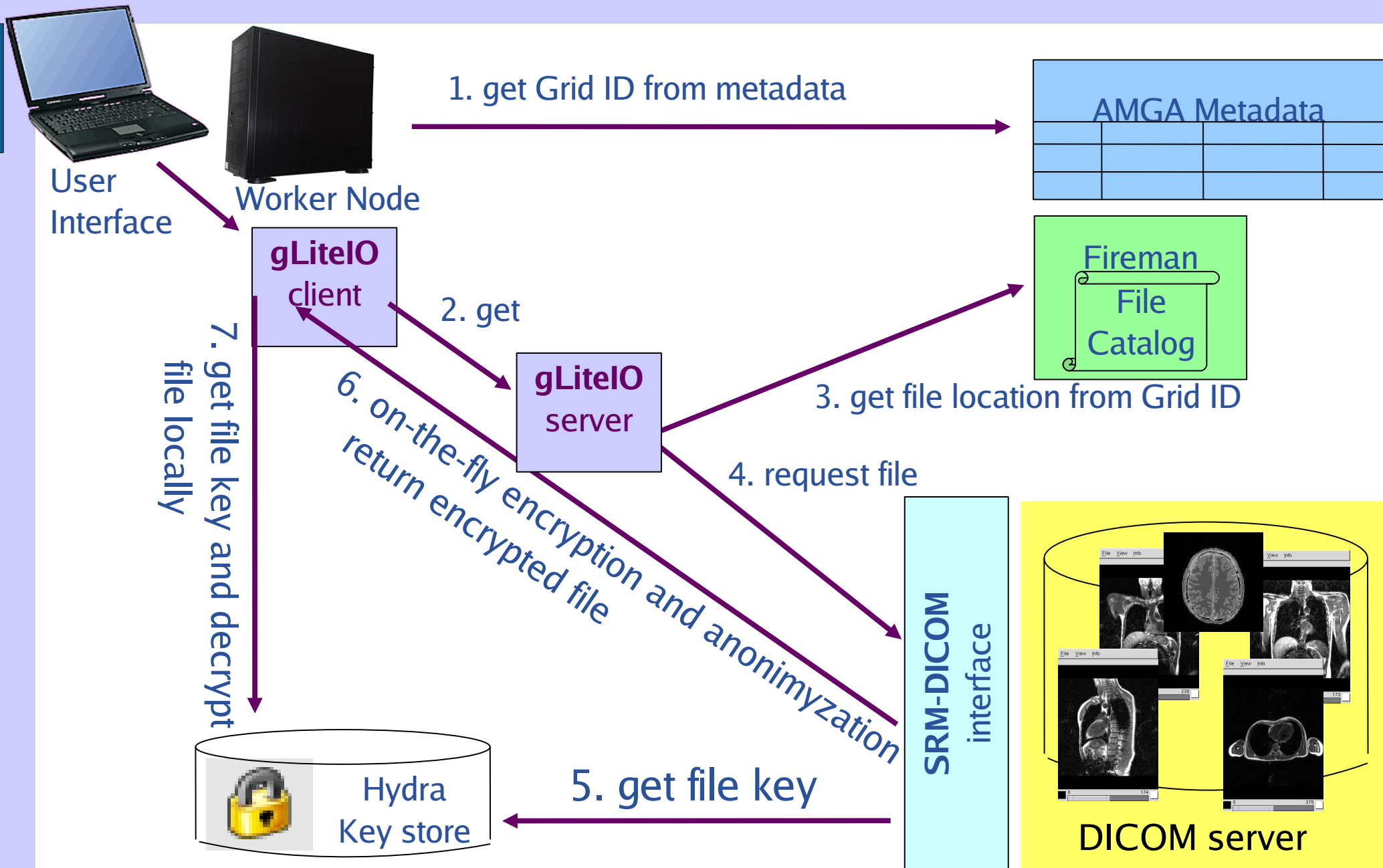
- Privacy
 - Fireman provides file level ACLs
 - gLiteIO provides transparent access control
 - AMGA provides metadata secured communication and ACLs
 - SRM-DICOM provides on-the-fly data anonymization
- Data protection
 - Hydra provides encryption/decryption transparently



Medical Data Registration



Medical Data Retrieval



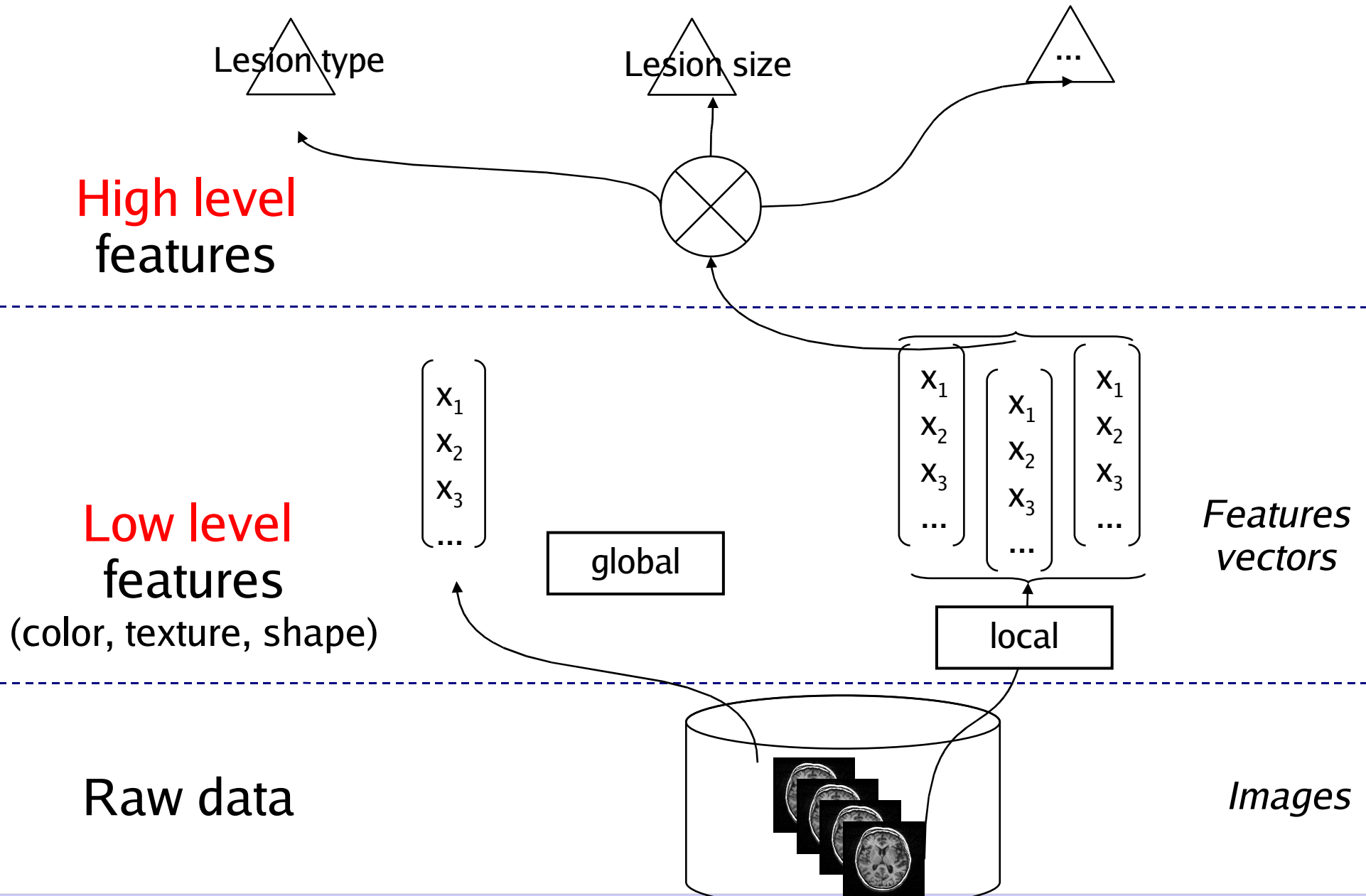


Medical Image Indexation

Tristan Glatard's Master Thesis 2004

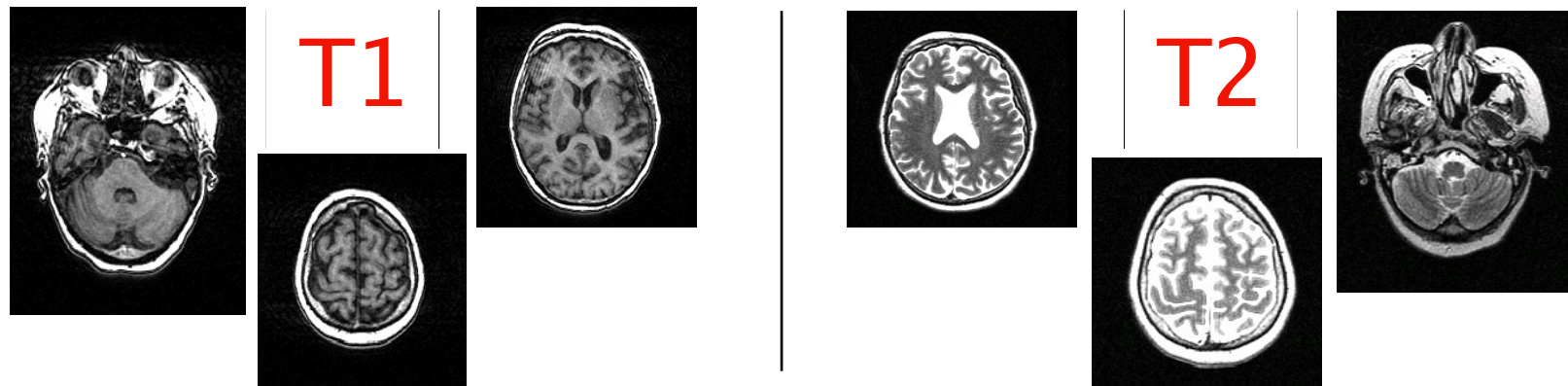


Indexation levels



Data sets

- ▶ Brain images database:
804 images - 2 ponderations



- ▶ Cardiac images database:
170 images - 2 sequences 3D+t

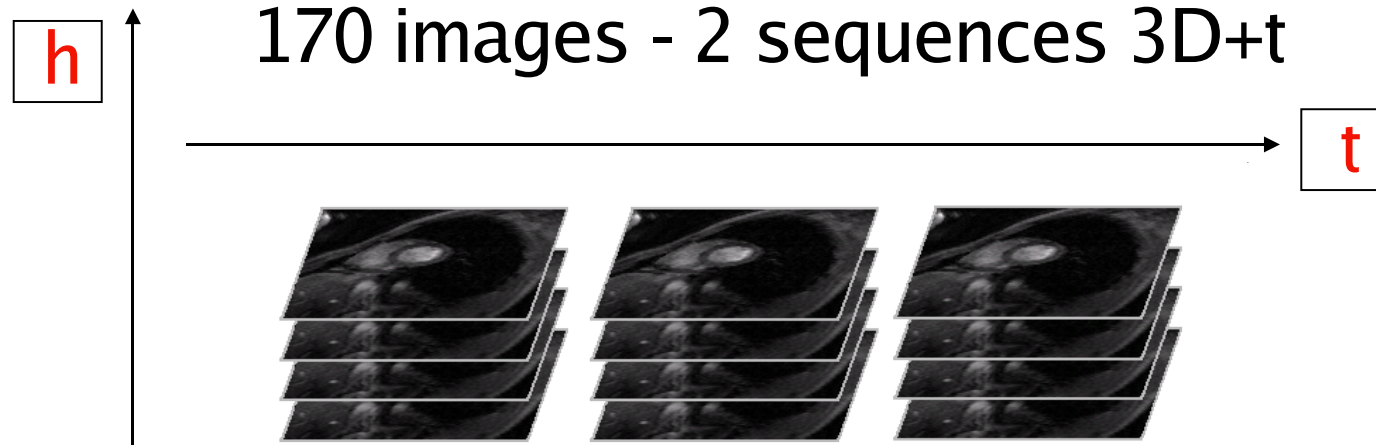


Image indexation and retrieval

▶ Brain images

- Using intensity histogram
- Separation T1 / T2
 - ➔ 2.1% of data wrongly classified
- Find an image similar to a reference one
 - ➔ Mean of 1.6% of data wrongly selected

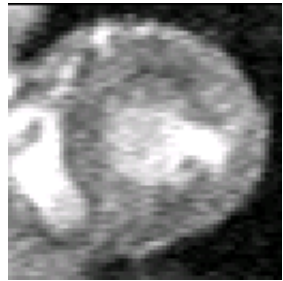
▶ Cardiac images

- Using Gabor filters for texture characteristics
- Identification of the slice number ($1 \leq s \leq 10$)
 - ➔ Standard deviation of the slice number in each group of slices:
 - σ_{\max} = 0.84 slice
 - σ_{mean} = 0.44 slice
- Find a slice similar to a reference one
 - σ_{mean} = 0.23 slice

Tissues classification

► Results :

Cardiac images

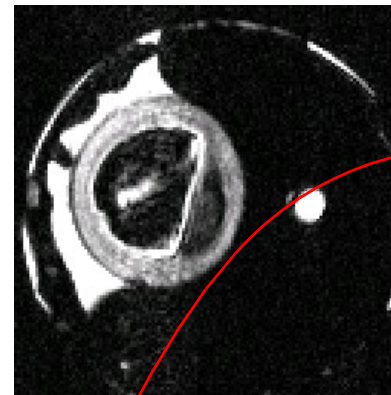


MRI

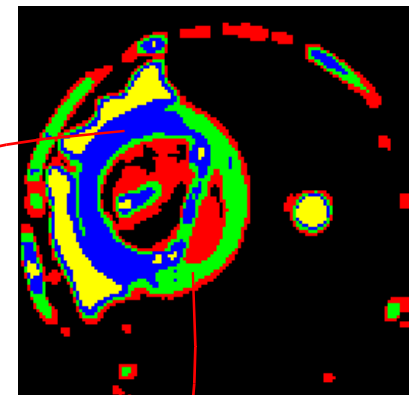


Segmented image

Vascular images



MRI

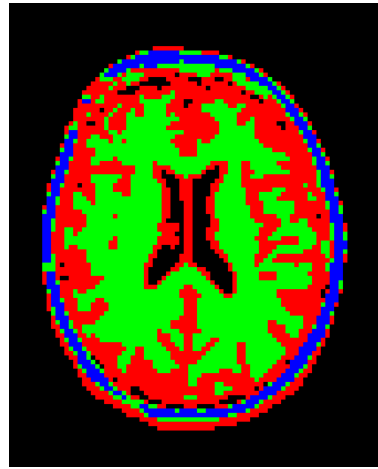


Segmented image

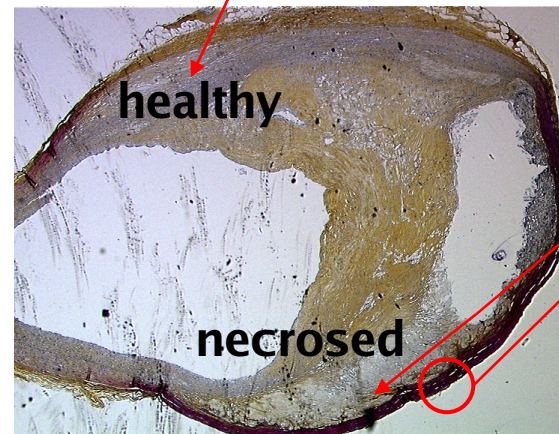
Brain images



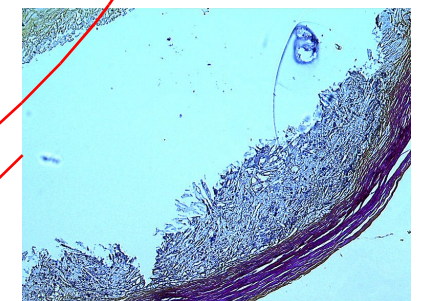
MRI



Segmented image



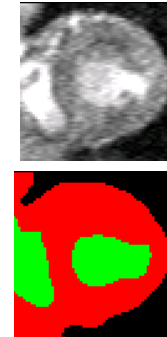
Histopathological image



Histopathological image

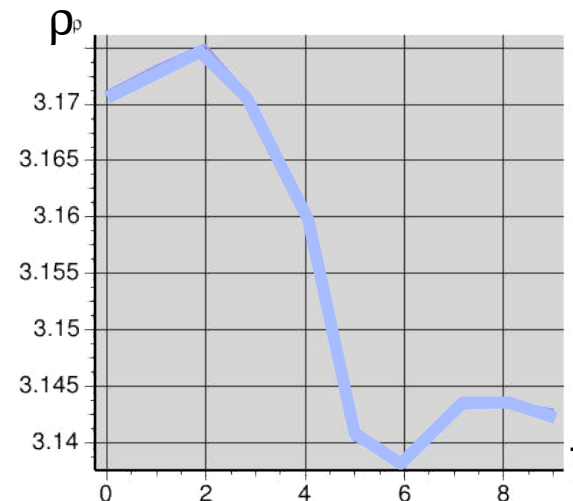
Characterizing the cardiac cycle

- Indexation :
 - Cardiac area extraction :
 - 3 area segmentation :
 - On the myocardium
(Gabor filter coefficients)



$$\rho = \frac{\sum_{\theta} \mu_{BF,\theta}}{\sum_{\theta} \mu_{HF,\theta}}$$

- Result :
 ρ evolution with respect to time



Conclusion

- ▶ NeuroLOG
 - Goals close to OnCoMedia
 - Starting January 2007
- ▶ Grid support for medical image analysis
 - Medical Data Manager
 - MOTEUR workflow engine
 - ...
- ▶ Preliminary work in image indexation