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# A Service-oriented Grid Infrastructure for Biomedical Data and Compute Services

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# Outline

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- ❑ The EU Integrated Project @neurIST
- ❑ @neurIST Grid Architecture and Middleware
- ❑ Compute Services
- ❑ Data Services
- ❑ Conclusions and Future Work

# EU Project @neurIST (2006-2009)

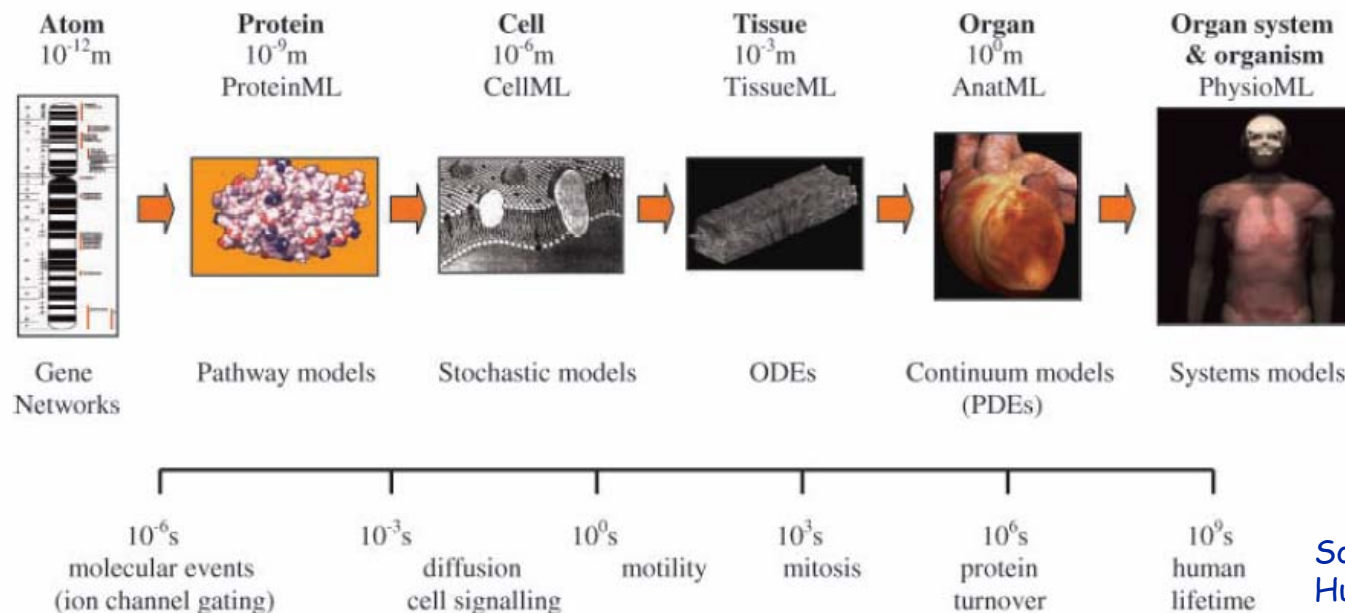
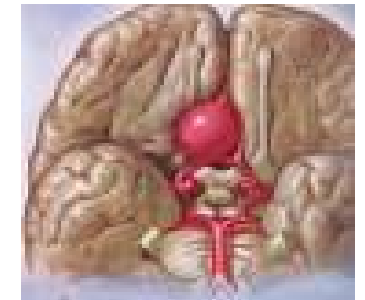


Integrated Biomedical Informatics for the Management of Cerebral Aneurysms

33 Partners, ~17,5 MEuro;

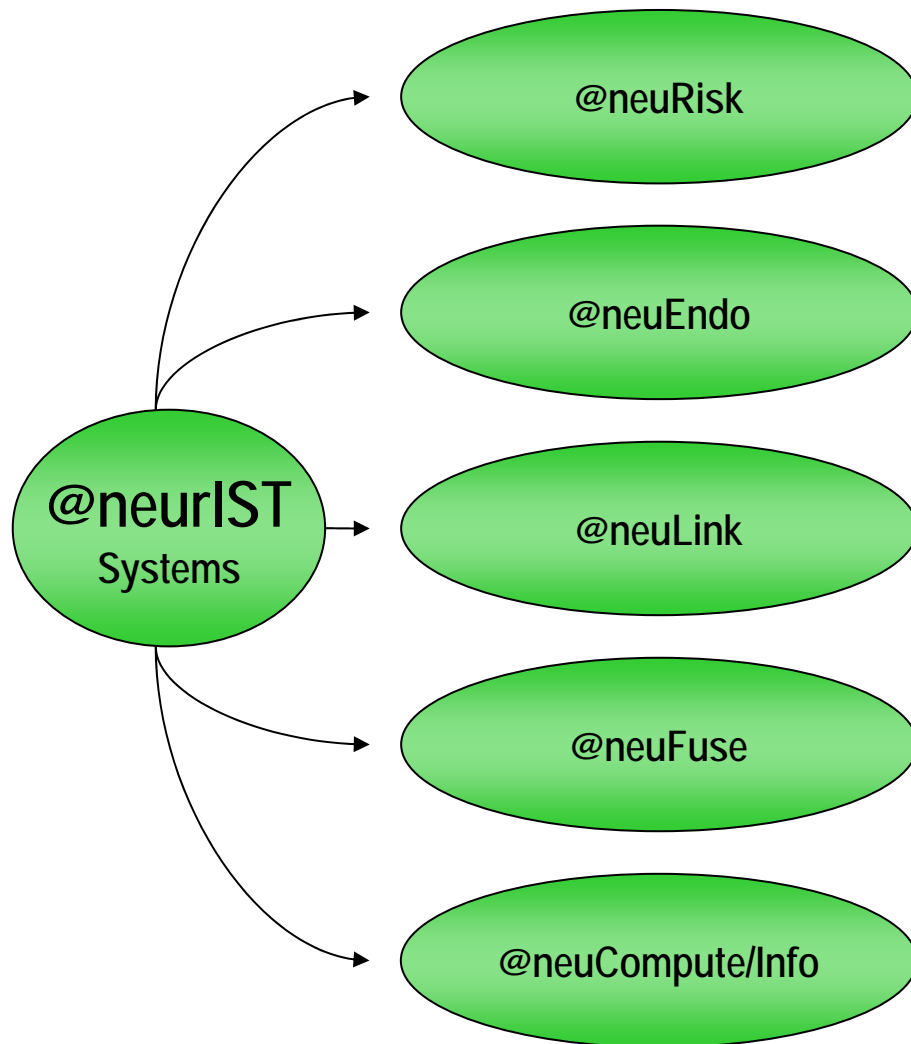
<http://www.aneurist.org>

- Development of a **generic IT infrastructure** for the management and processing of heterogeneous data for **diagnosis and treatment** of cerebral aneurysms.
- **On-demand simulation and data-integration services** handling **multi-scale, multi-modal** information at distributed sites

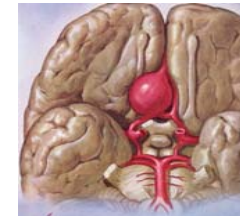


Source: Peter Hunter  
Human Physiome Project

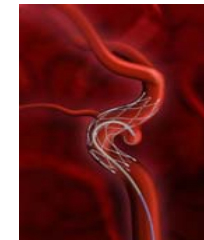
# @neurIST Integrative Application Suites



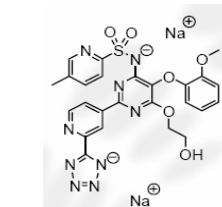
Improve **decision making processes** in the management of **unruptured aneurysms** by providing a score that integrates all the available information for **identifying at-risk patients** and reducing current over treatment



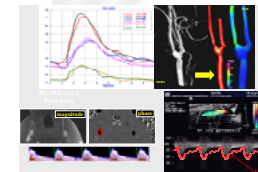
Support **computational design processes** towards a next generation of **smart flow-correcting implants** to treat **ruptured aneurysms** and reduce current treatment costs, side effects and recurrence.



Support the **knowledge discovery** for **linking genetics to disease**, vasospasm and blood clotting after cerebral hemorrhage



Support the **integration of modeling, simulation and visualization of multimodal data**



Support integration of data and computing resources.



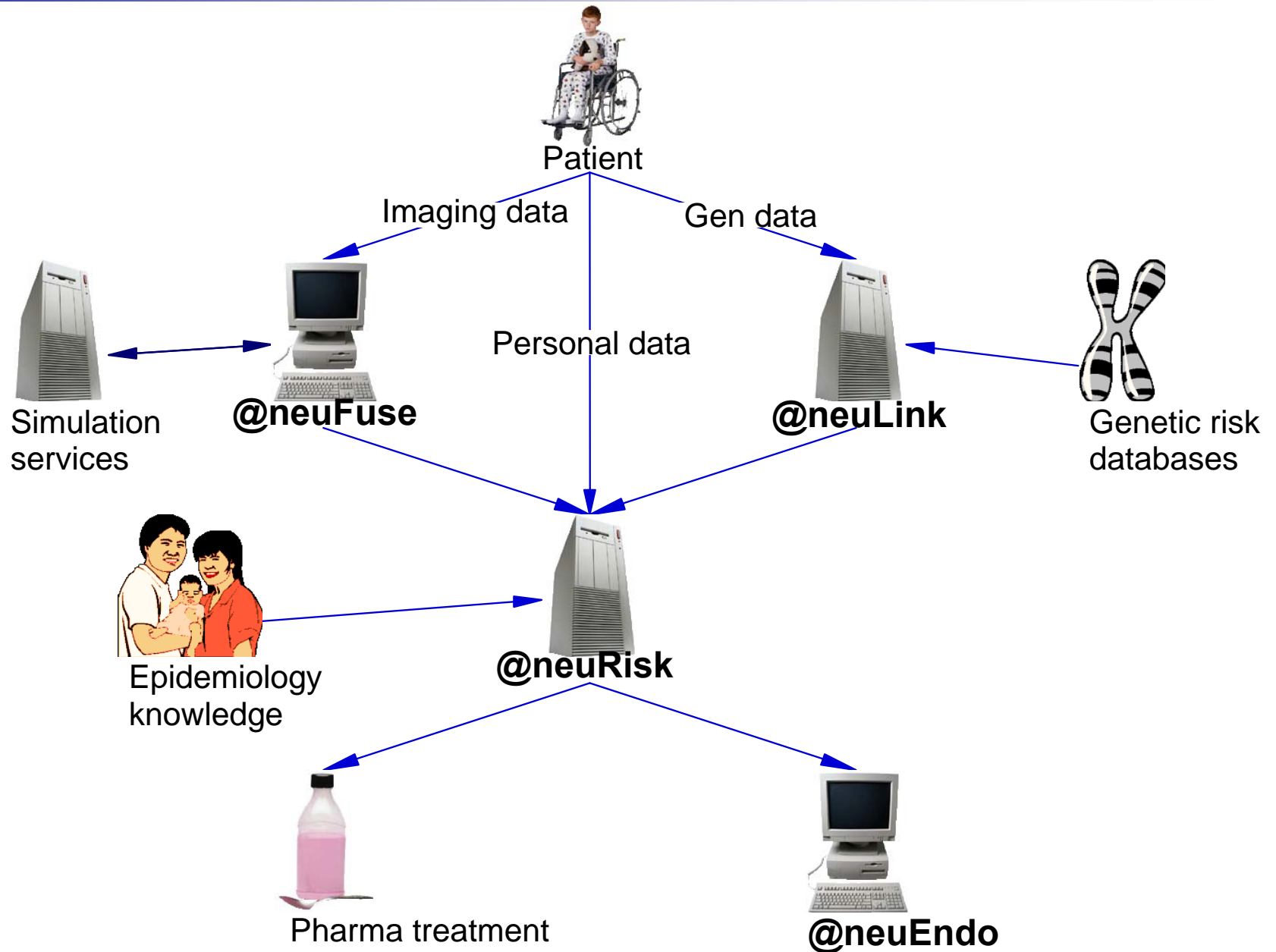
Support Tools



Enabling IT



# @neurIST Integrative Application Suites



# @neurIST Service-Oriented Grid Architecture

## Integrative Application Suites

**@neuRisk**

Integrative rupture  
risk assesment

**@neuLink**

Linking genetics  
to disease

**@neuEndo**

Virtual endovascular  
treatment planning

**@neuFuse**

Multimodal data  
processing & fusion

## Computing and Infostructure

**@neuCompute**

Computing and data transport services

Job & data handling interface

Compute  
services

Data staging  
services

**@neuInfo**

Distributed and heterogeneous data access

Data service interface

Data services  
OGSA-DAI

Data Mediation  
GDMS

**Core Grid Middleware: GEMSS and InnerGrid**

## Information and Compute Resources

**Public databases**

Genetic: EBI,NCBI  
Literature: Medline,  
etc.

**Hospital  
Information  
systems**

HUG, USFD, etc.

**Private  
databases**

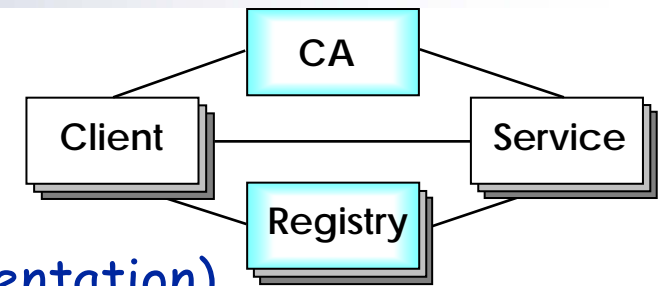
COTS stents, coils,  
etc

**Modelling and  
Simulation  
Applications**

# GEMSS - Architecture & Middleware

## ❑ Service oriented architecture

- Based on **standard Web Services** technology.
- WSDL, SOAP, WSRF
- End-to-End Security (own WS-Security implementation)



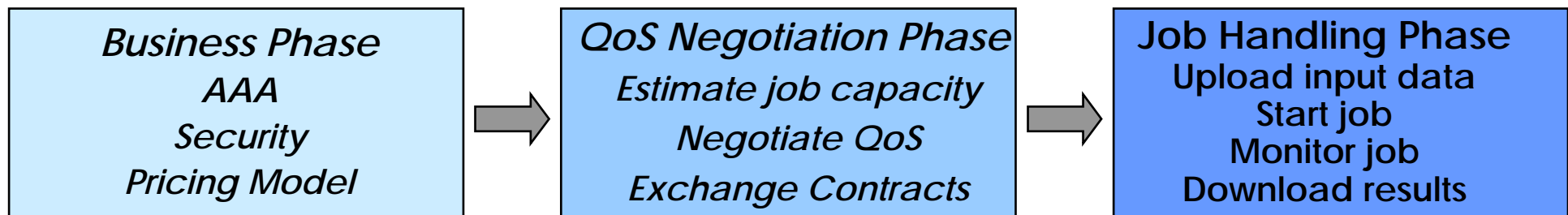
## ❑ Service-Provision Framework

- Virtualization of **HPC applications/data sources** as **services**
- **Application-level QoS guarantees** (response time, price, location, ...)

## ❑ Grid Programming Framework

- Construction of **Client-side Grid applications** using **High-Level APIs**

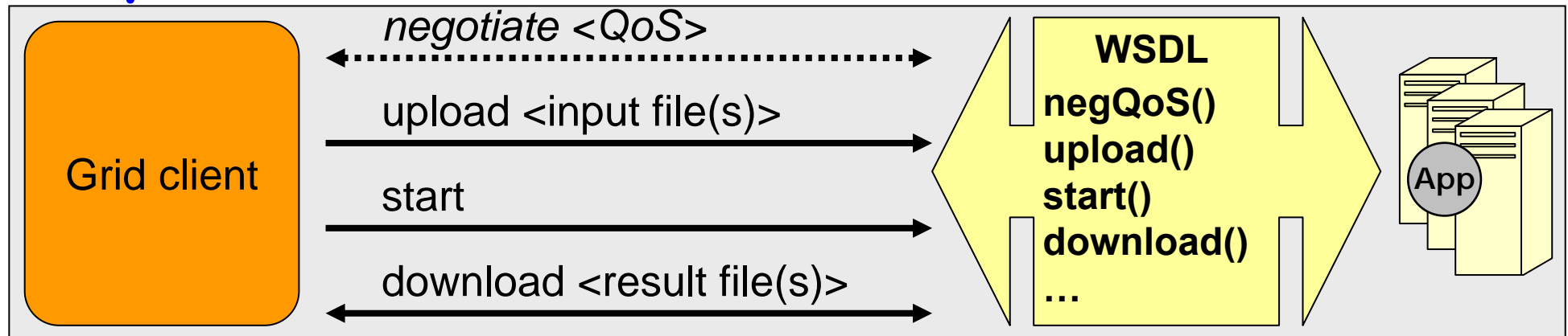
## ❑ Service access model



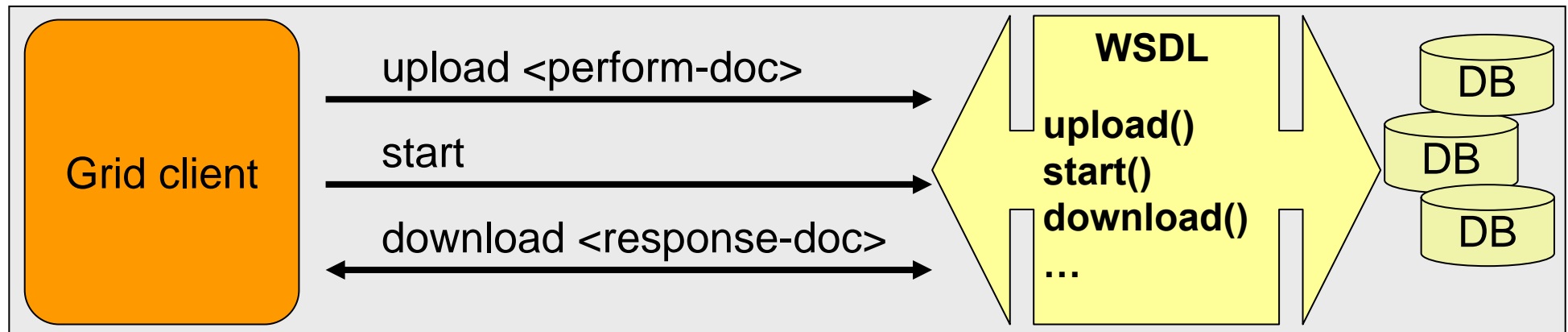
# Uniform Grid Services

Applications and data virtualized as Grid/Web Services with uniform interface (WSDL) and protocol/transport (SOAP/HTTP).

## Compute services



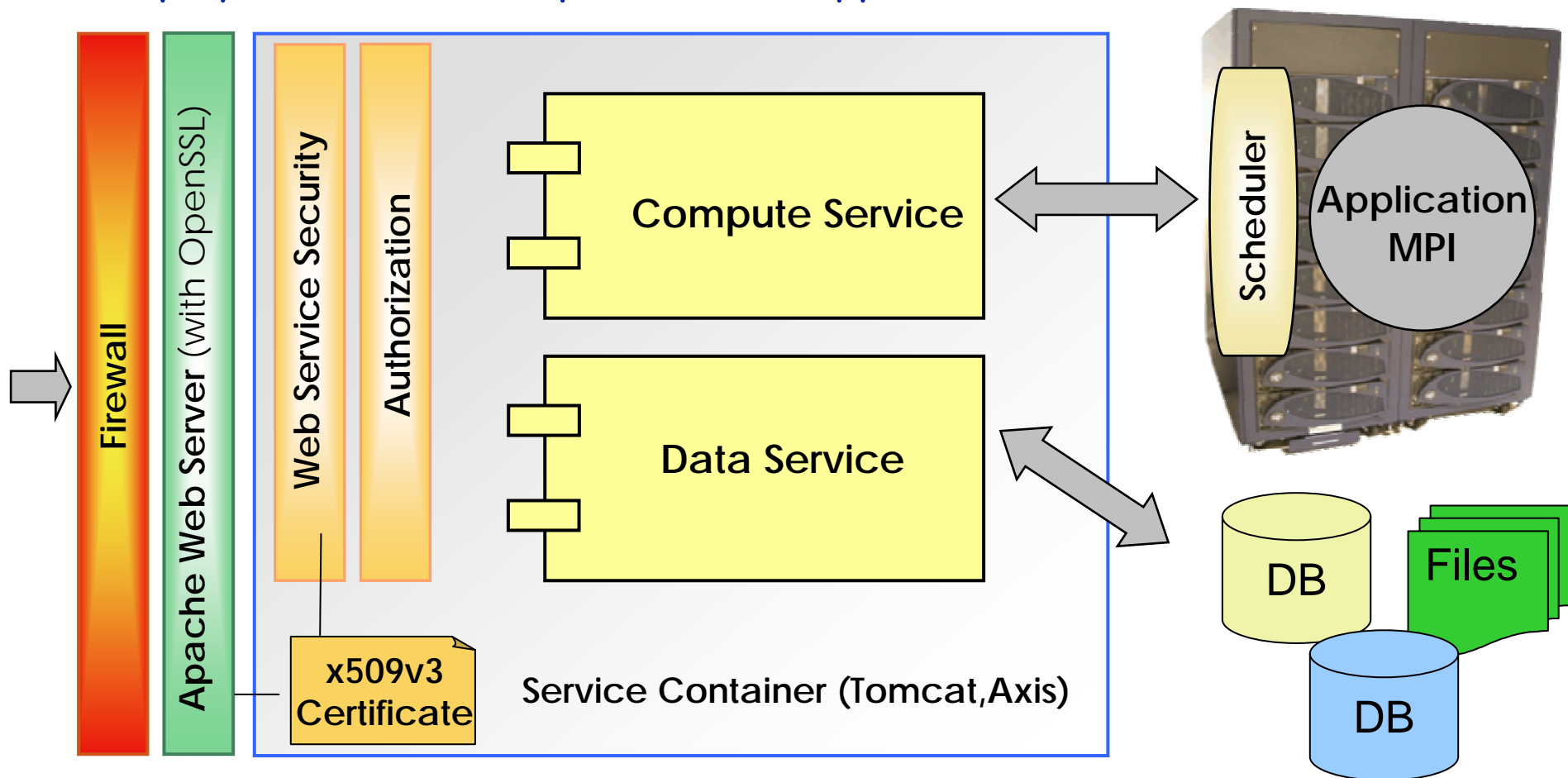
## Data services





# Service Provision Infrastructure

- ❑ Hide complexity of the Grid from the Grid service providers/developers
- ❑ End-to-end security; Firewall-friendly.
- ❑ Deploytool *automates* provision of applications/ data sources as Grid services



# HPC Application → Grid Application Service

(1) Install HPC application on a Grid host

executable + libraries, etc

(2) Specify Application Descriptor (Deploytool)

I/O files, job script, status script, resource constraints

(3) Specify QoS Attributes, QoS Models, and Descriptors

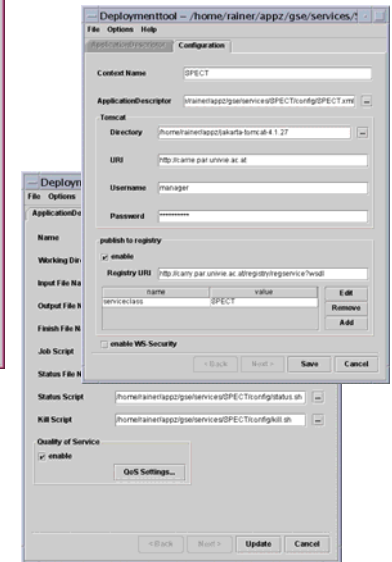
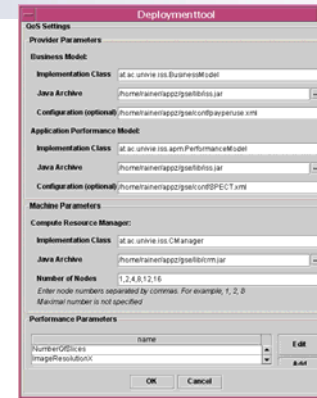
- e.g.: Performance model

IN: Request Descriptor (input meta data, # processors)

OUT: Performance Descriptor (run time, memory, etc.)

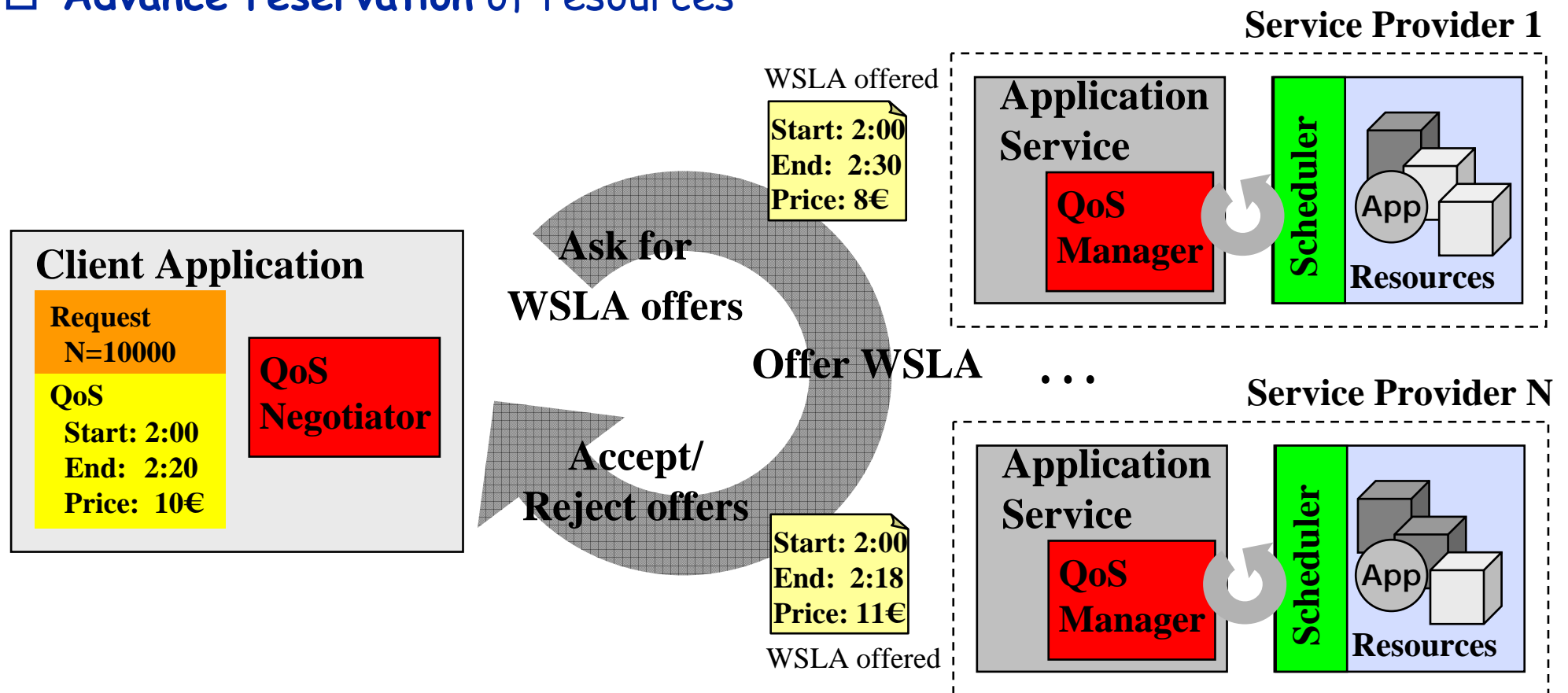
- Price model

(5) Deploy application service (Deploytool)



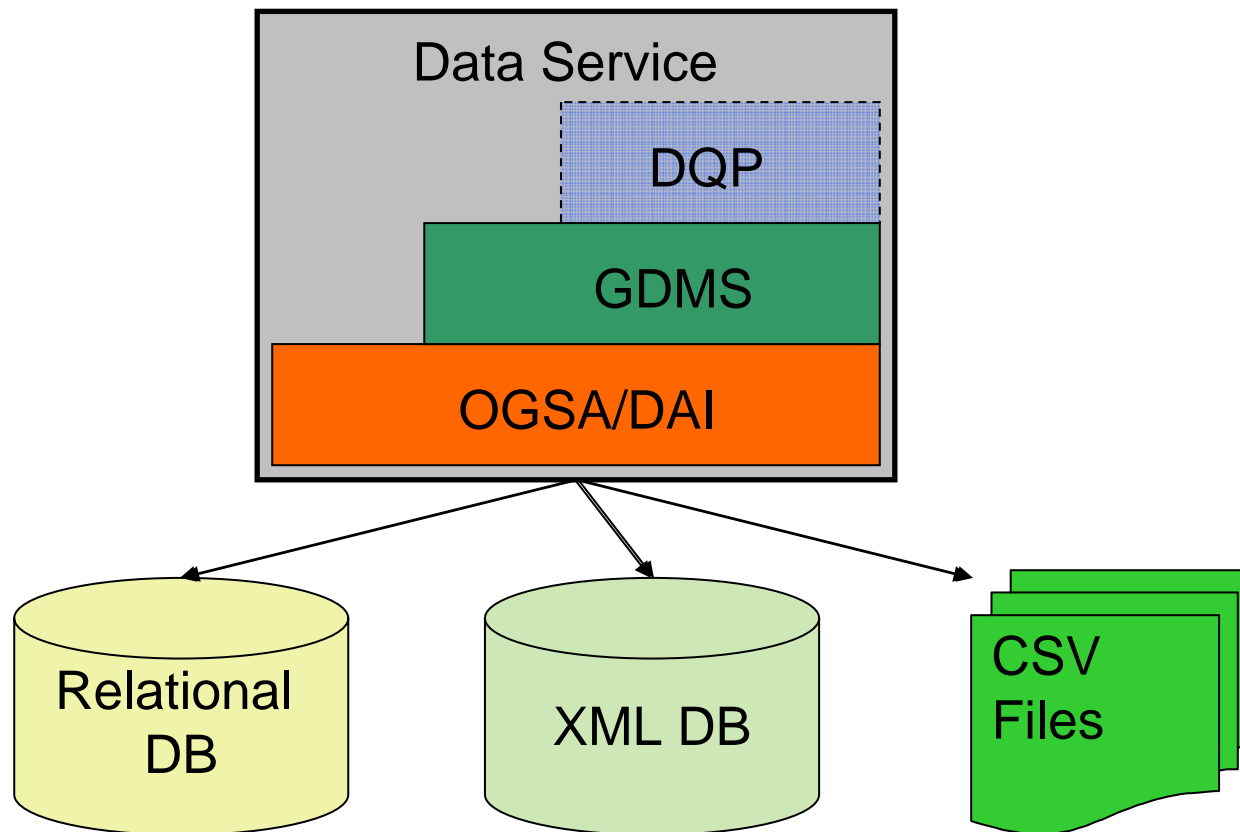
# On Demand Supercomputing

- Client driven QoS negotiation with potential service providers
  - Client supplies: QoS requirements (e.g. response time), Input meta data
- Signed **Web Service Level Agreement (WSLA)** exchanged with winner
- Advance reservation of resources



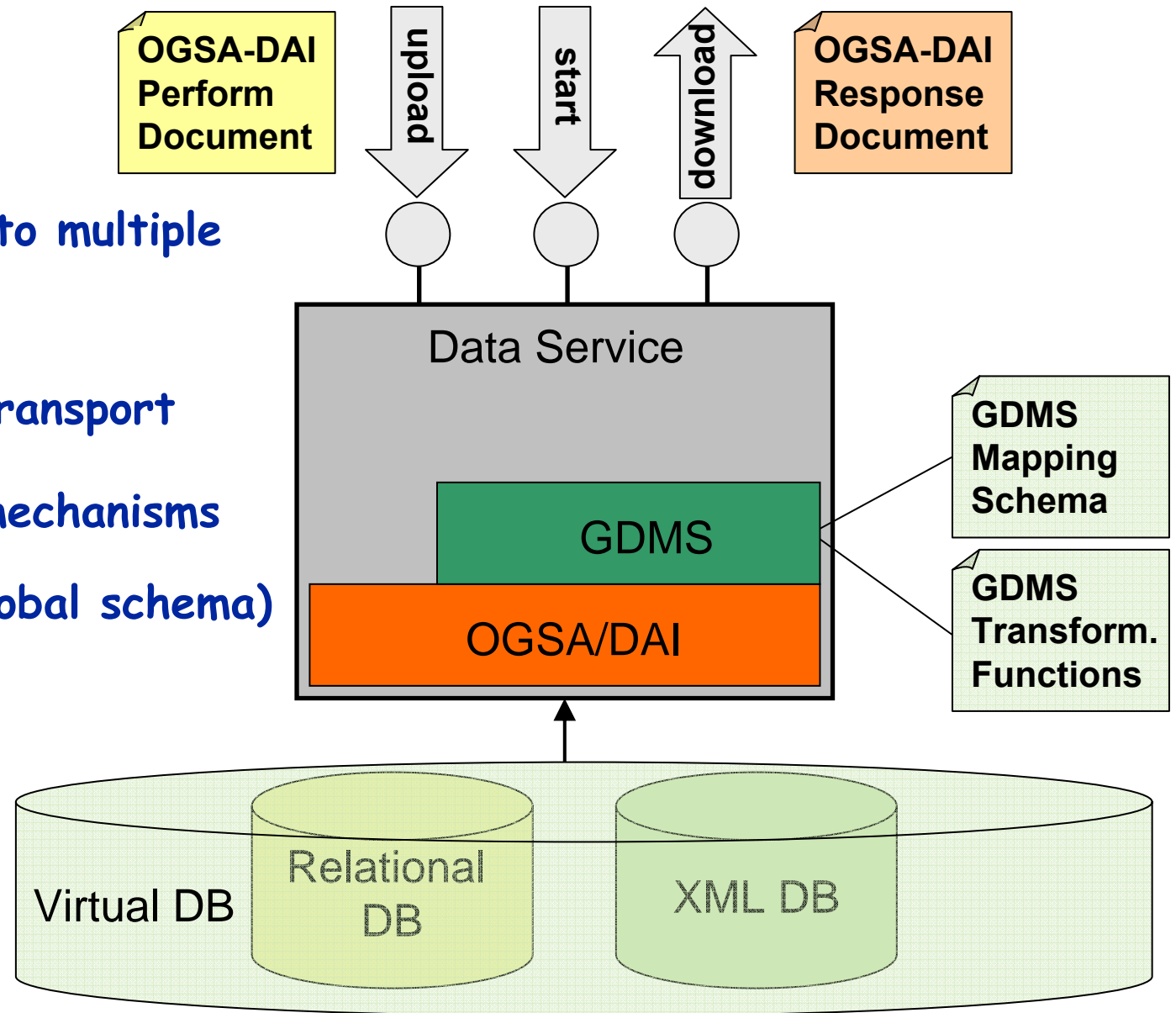
# Data Services

- Same interface and access/security mechanisms as compute services
- Utilize OGSA-DAI to hide heterogeneity of data sources
- **Can be configured for data mediation by utilizing GDMS**
- Will be extended with OGSA-DQP to optimize distributed queries



# Data Services - Mediation (GDMS)

- Transparent access to multiple data sources
- GEMSS security & transport
- OGSA/DAI access mechanisms w.r.t. virtual DB (global schema)
- **read-only access !!**



# Conclusions

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## @neurIST Project

- ❑ Development of a **generic Grid infrastructure** for the management and processing of heterogeneous data for diagnosis and treatment.
- ❑ SLA-based **on-demand simulation and data-integration services** handling multi-scale, multi-modal information at distributed sites.

## @neurIST Grid Environment

- ❑ Compute and Data services with uniform interface based on WS-Standards
- ❑ leverages GEMSS, InnerGrid and OGSA-DAI/DQP developments

## Challenges

- ❑ Semantic Grid Infrastructure, Ontologies
- ❑ Security, legal issues, provenance wrt. to patient data

ANSYS Europe Ltd., UK

Advanced Simulation and Design GmbH, DE

Cancer Research UK

Ecole Polytechnique Federale de Lausanne, CH

Erasmus University Medical Centre, Rotterdam, NL

FIMIM, Foundation IMIM, ES

Fraunhofer Gesellschaft (SCAI), DE

Grid Systems S.A., ES

IDAC Ltd., IE

IMIM (Inst. Municipal d'Assistencia Sanitaria), ES

Infermed Ltd., UK

INSERM,FR

Hospital "Clinic I Provincial de" Barcelona, ES

KTH (Kungliga Technische Hoegskolan), SE

Medical U. Pecs, HU

Neuroangiografia Terepeutica S.L, ES

NEC Europe Ltd., DE

Philips Medical Systems, NL

Supercomputing Solutions S.R.L., IT

The Thrombosis Research Institute, UK

U. Clinic Freiburg, DE

U. Geneva (and U. Hospital), CH

U. Luton, UK

U. Medical Centre, Utrecht, NL

U. Oxford, UK

U. Pompeu Fabra, ES (Coordinator)

U. Sheffield, UK

U. Vienna, Austria

William Cook Europe APS, Denmark

*Tohoku U., JP*

*George Mason, US*

*Mayo Clinic, US*

*Centre for Biomolecular Discovery,*

*U. Wellington, NZ*