

aneurIST
Integrated biomedical informatics for the management of cerebral aneurysms

The @neurIST Grid Infrastructure
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for the Aneurist Consortium
www.aneurist.org
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Outline

- The @neurIST Project – Goals and Objectives
- @neurIST SOA & Grid Middleware
- Compute Services
- Data Services
- Semantic Technologies
- Conclusion

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Integrated Biomedical Informatics for the Management of Cerebral Aneurysms

- Integrated Project, FP6, European Commission
- Project duration: 2006-2009 (48 months)
- 33 Partners
- Budget: ~17,5 MEuro



Objectives:

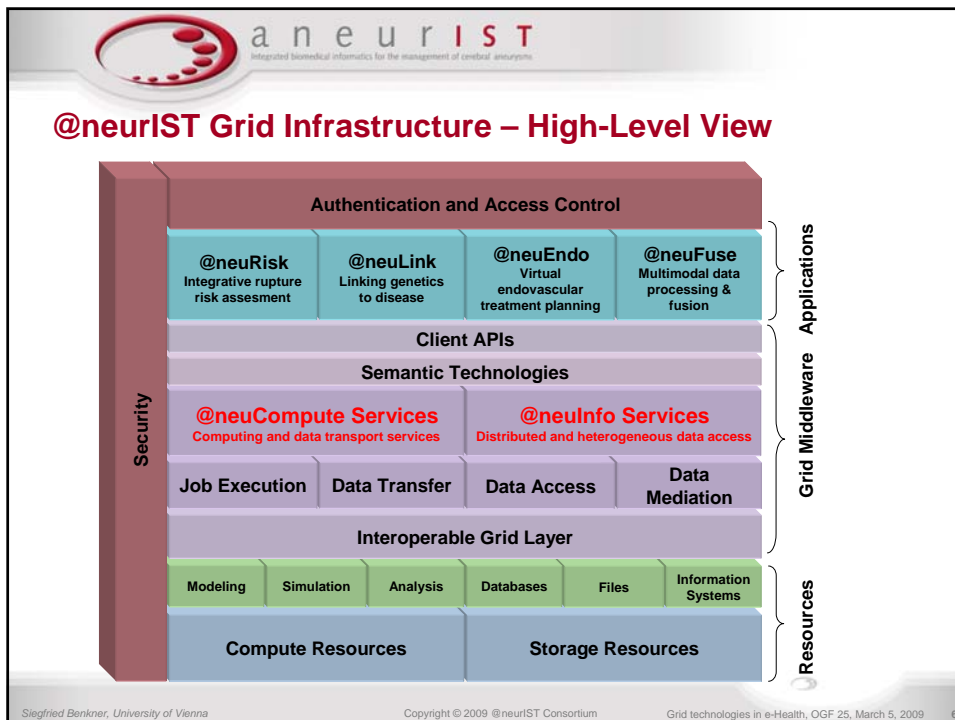
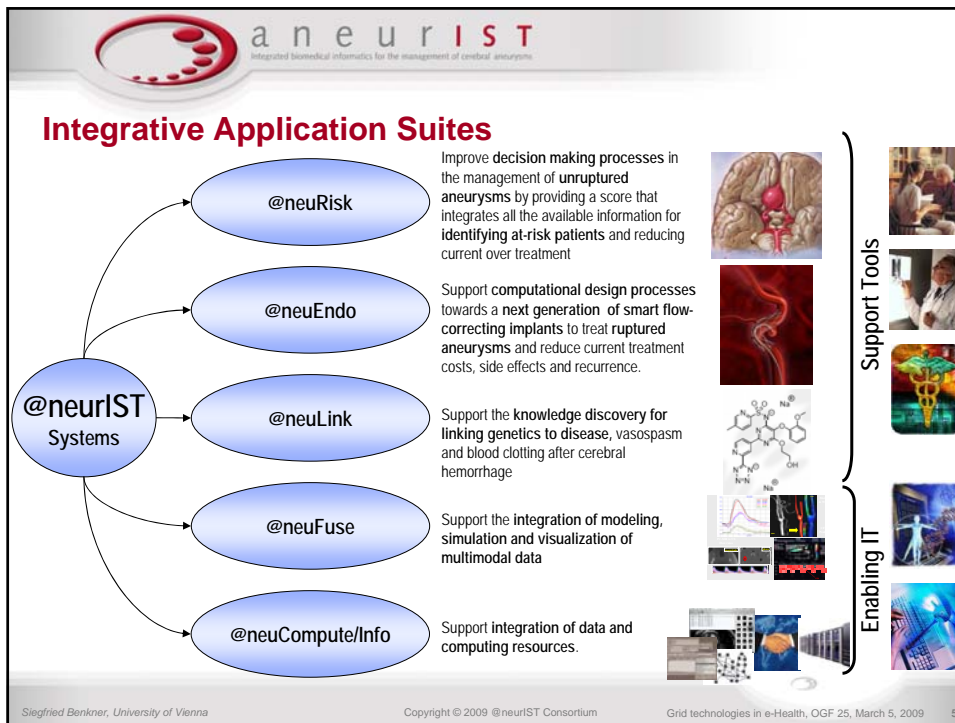
- Development of a **generic Grid infrastructure** for the **management and processing of heterogeneous data** associated with the diagnosis and treatment of cerebral aneurysms and subarachnoid haemorrhage.
- Transform the management of cerebral aneurysm by providing new insight, **personalised risk assessment** and methods for the **design of improved medical devices** and treatment protocols.

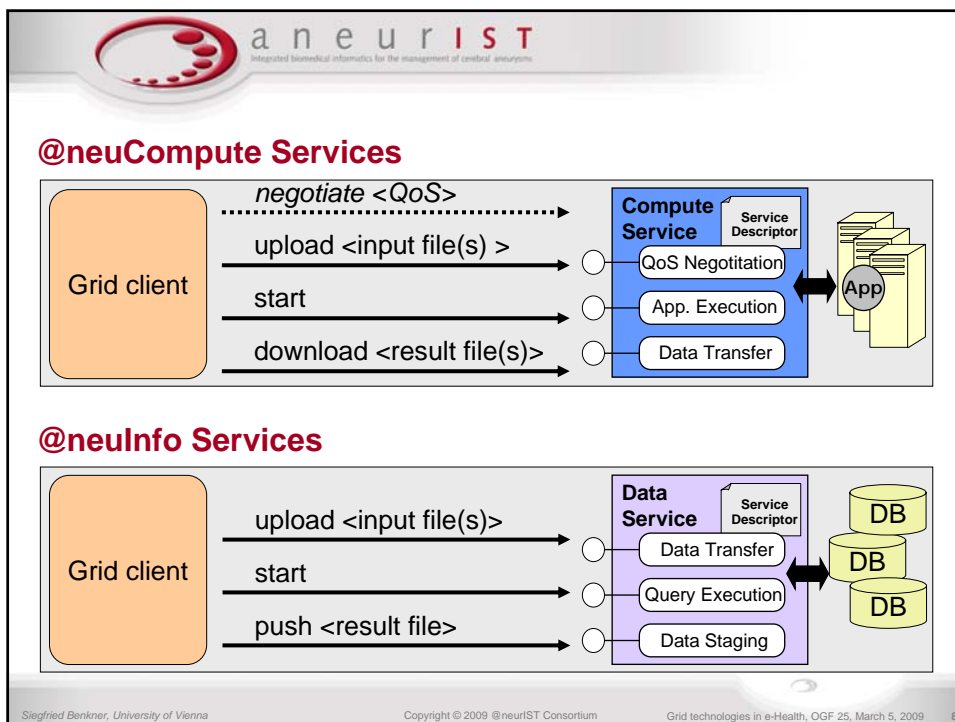
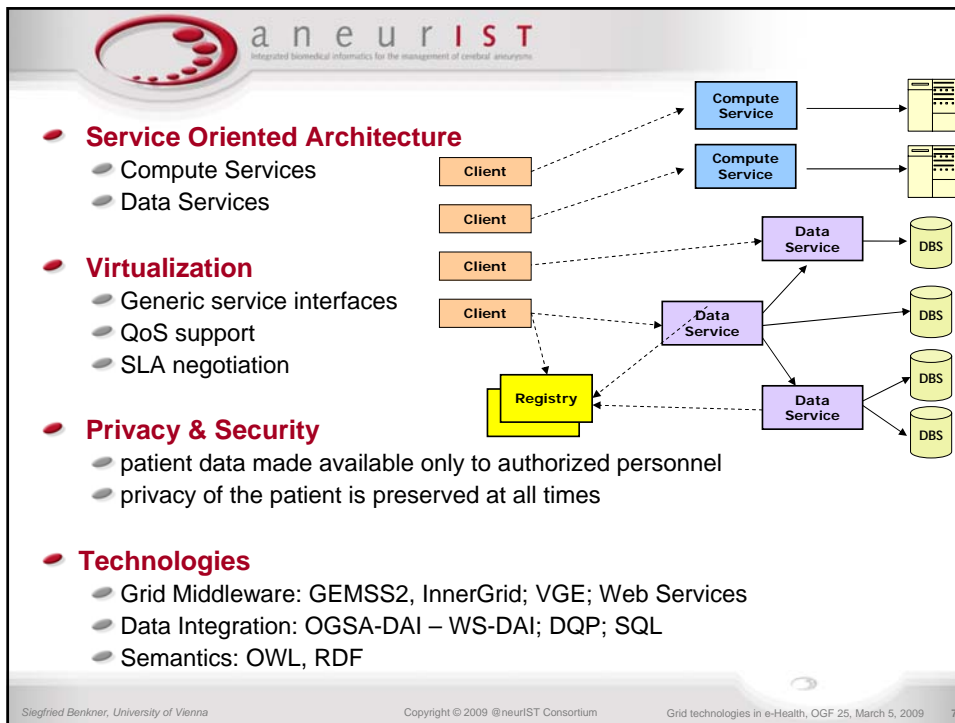
Personalised risk assessment could reduce unnecessary treatment by 50%, with concomitant savings estimated in the order of several billions of Euros per year.



@neurIST Consortium (www.aneurist.org)

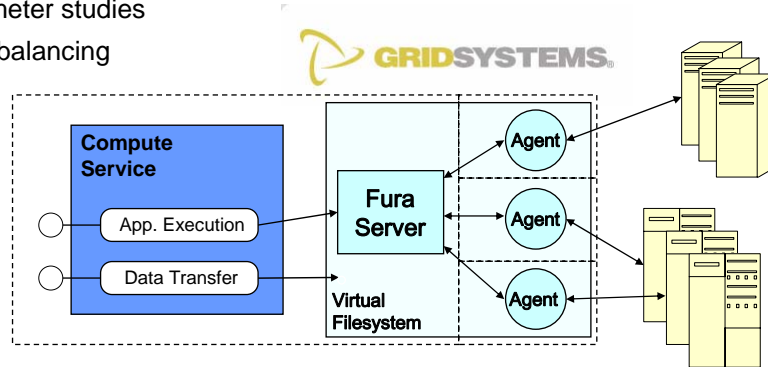
- | | |
|---|---|
| ANSYS Europe Ltd., UK | Philips Medical Systems, NL |
| Advanced Simulation and Design GmbH, DE | Supercomputing Solutions S.R.L., IT |
| Cancer Research UK | The Thrombosis Research Institute, UK |
| Ecole Polytechnique Federale de Lausanne, CH | U. Clinic Freiburg, DE |
| Erasmus University Medical Centre, Rotterdam, NL | U. Geneva (and U. Hospital), CH |
| Fraunhofer Gesellschaft (SCAI), DE | U. Luton, UK |
| Grid Systems S.A., ES | U. Medical Centre, Utrecht, NL |
| IDAC Ltd., IE | U. Oxford, UK |
| IMIM (Inst. Municipal d'Assistencia Sanitaria), ES | <u>U. Pompeu Fabra, ES (Coordinator)</u> |
| Infermed Ltd., UK | U. Sheffield, UK |
| INSERM, FR | U. Vienna, Austria |
| Hospital "Clinic I Provincial de" Barcelona, ES | William Cook Europe APS, Denmark |
| KTH (Kungliga Technische Hoegskolan), SE | Tohoku U., JP |
| Medical U. Pecs, HU | George Mason, US |
| Neuroangiografia Terepeutica S.L, ES | Mayo Clinic, US |
| NEC Europe Ltd., DE | Centre for Biomolecular Discovery,
U. Wellington, NZ |





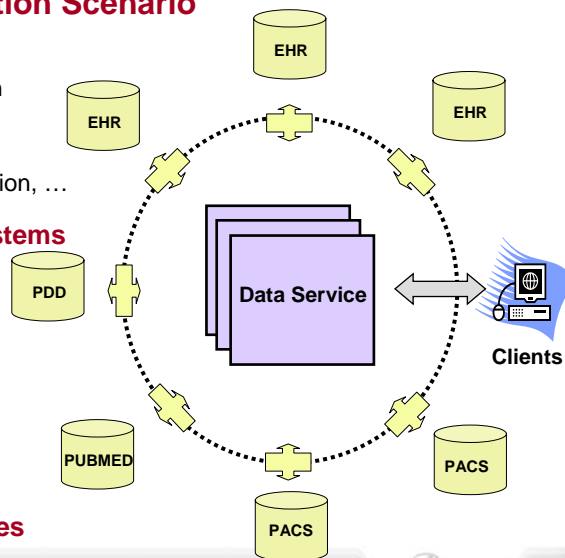
Compute Service Scenario - Interaction with Fura

- Commercial Grid middleware developed by Grid Systems S.A.
- Intra-organizational Grid
- High-throughput computing
- Parameter studies
- Load balancing



@neurIST Data Integration Scenario

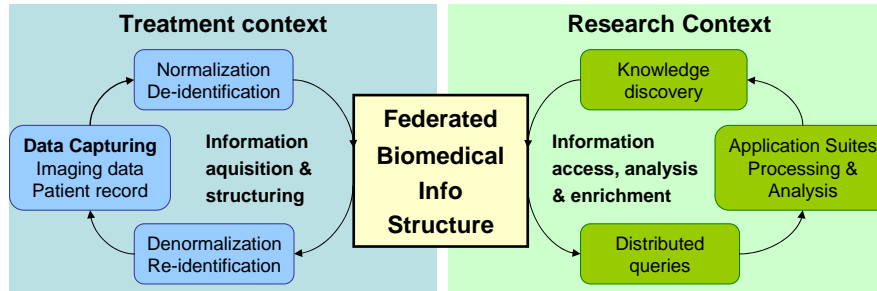
- **Approach**
 - Semantic Data Mediation
 - Federation of Services
 - CRIM, Ontology
 - Security, Pseudonymization, ...
- **Hospital information systems**
 - Sheffield, Geneva, Rotterdam, ...
 - EHR, PACS, ...
- **Public databases**
 - Genetic: EBI, NCBI
 - Literature: Medline, etc.
- **Product design databases**
 - COTS stents, coils, etc.



• Clinical Reference Information Model (CRIM)

Defines all information to be captured for a patient

- clinical information (imaging, diagnostic and treatment data, ...)
- administrative information
- research results produced (indicators)



• Biomedical data infrastructure

Two different architectures (CIS → anonymized DB; on-the-fly access to CIS)

@neulInfo Data Services

- **Virtualization** of heterogeneous data sources as services

- Same access mechanisms as compute services

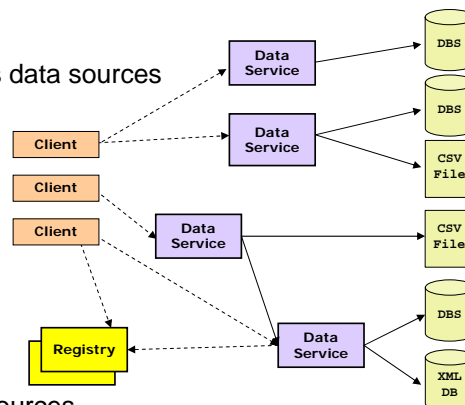
- Different Variants

- **Data Access Services**
access to single data source

- **Data Mediation Services**
integration of multiple data sources

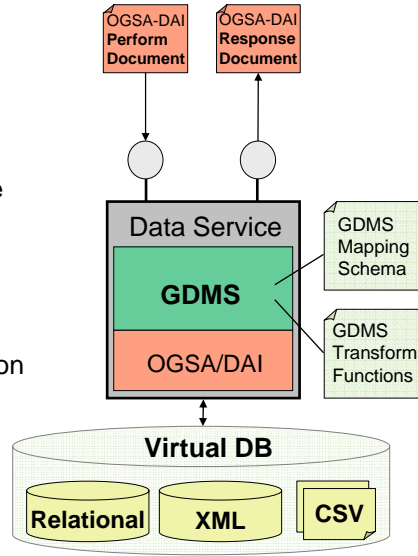
- Based on (Grid) standards

- OGSA/DAI, OGSA/DQP
- SQL, XML



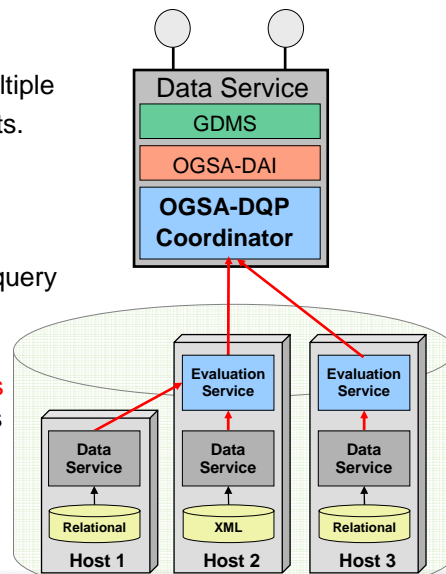
Data Mediation Services

- Transparent access to multiple data sources
 - Virtual global schema
 - Data stays where it is; always live
 - Schema, language and interface transparency
- GDMS Mapping Schema
 - Global-as-View query reformulation
 - Different views of data
- GDMS Transformation Functions
 - On-the-fly data transformation via user-defined Java methods



Distributed Query Processing

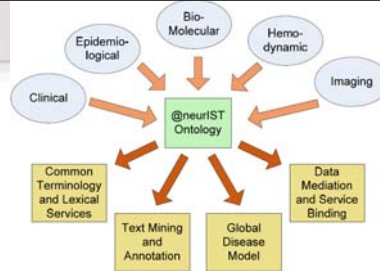
- Optimize complex queries using multiple evaluation services on different hosts.
- based on **OGSA-DQP**
- GDMS generates query plan** from query against global schema
- DQP coordinator service distributes query plan** onto evaluation services
- Evaluation services execute parts of query plan in parallel.



@neurIST Semantic Technologies

@neurIST Ontology

- Global “schema” of the disease
- Implemented in OWL-DL
- Incorporates existing ontologies
 - FMA (Foundational Model of Anatomy)
 - GO (Gene Ontology), DOLCE as Upper Ontology
 - Concepts mapped to UMLS (Unified Medical Language System)



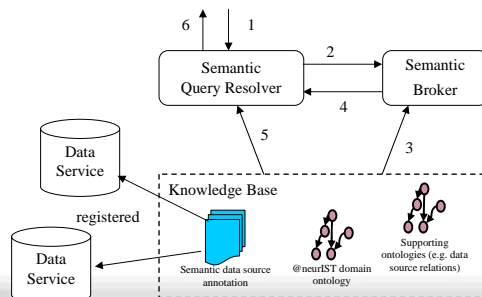
Classes	Relationship Types	UMLS Map
2319	85	1183

Semantic grid support (Ongoing Work!)

- Semantic **annotation** of services
- Semantic **broker** (semantic service discovery)
- Semantic **query resolver** (reduce relational complexity)
- Semantic **mediation** between data sources (generation of mapping files)

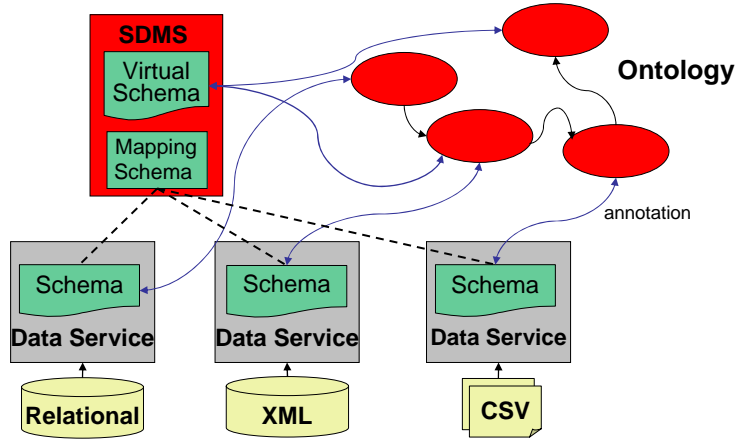
Semantic Technologies in @neulInfo

- Goal: simplify access to complex distributed data sources utilizing @neurIST ontology concepts
- Semantic Broker to answer the question „What data to combine?“
- Semantic Query Resolver to answer the question „How to combine?“
 - reduces relational complexity
 - (semi-)automatic generation of mapping schemes



Development of SQR based on UNITY framework by University of British Columbia.

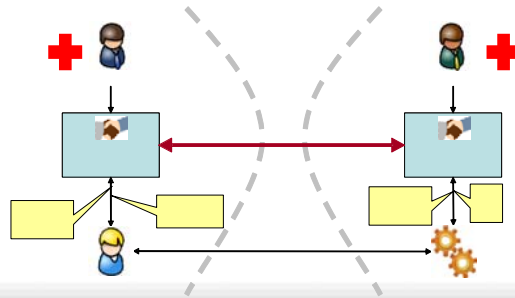
Semantic Data Mediation Services



- (Semi-)Automatic generation of mapping schemas
- Keeps source data untouched (annotations stored in separate repository)

@neurIST Trust & Security

- Identity established via Security credentials (certificates, ...)
- Local security token service (STS) issues security token (SAML) with associated attributes.
- STS of service provider controls access to services by enforcing local policy (XACML).
- Message and transport layer security based on standards.





Conclusions

• @neurIST Project

- Develops **generic Grid infrastructure** for the management and processing of heterogeneous data **for diagnosis and treatment development for multi-factorial diseases**.
- 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, VGE, Fura and OGSA-DAI/DQP developments

• Challenges

- Semantic Data Integration
- Security, legal issues, provenance wrt. to patient data



Contact

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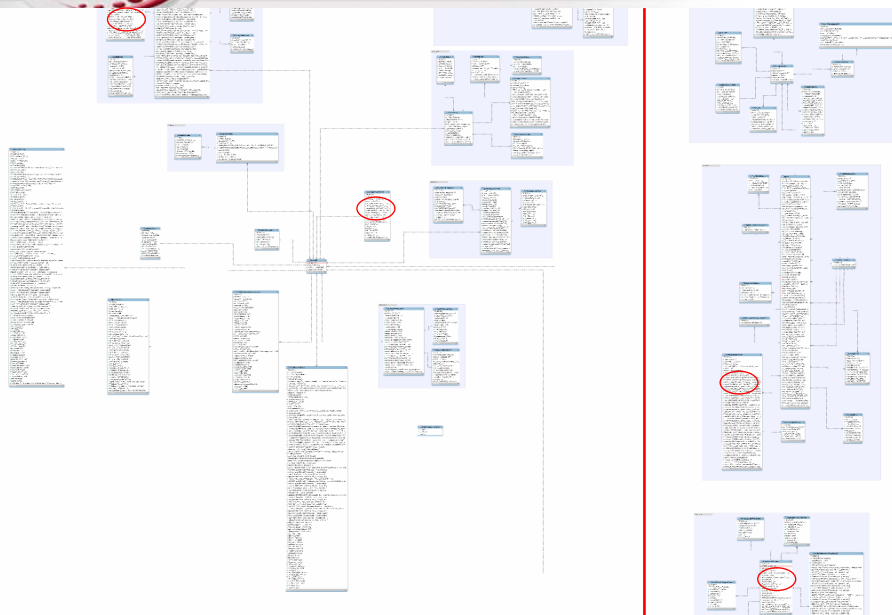


Semantic Query Resolver – Use Case

- Find patients who
 - Did not have ischemic events
 - admission happend with symptomatic aneurism with 5 mm diameter at the Arteria Basilaris
 - some cerebrale perfusion X occurred
- Target Concepts for semantic query:
 - aneurysm_state
 - intracranial_aneurysm_location
 - maxium_diameter
 - cerebral_ischemic_event
 - regional_cerebral_perfusion_reserver
- Just 4 target tables in two DBs, but
 - distance between them high (6 joins required)
 - find the right ones in around 100



Semantic Query Resolver – Use Case



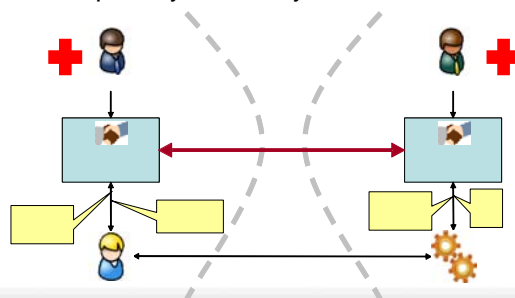
@neurIST Security Architecture

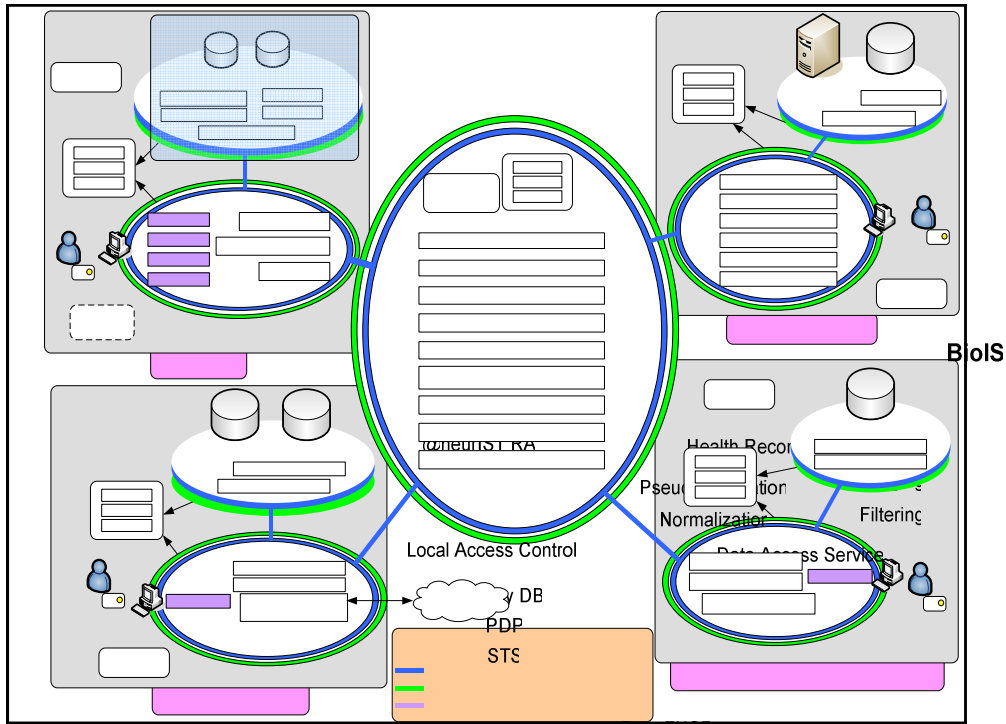
- Pseudonymisation Service
- End-to-end security
- Attribute-based access control (SAML, XACML)
- Certificate and Registration Authorities; Federated VO model
- Security Token Service
- Logging, Filtering Services
- Auditing
- Provenance

built on top of Web services security standards.

@neurIST Trust & Security

- Identity established via Security credentials (certificates, ...)
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- Message and transport layer security based on standards.





- @neurFUSE Service Discovery
- @neurRISK Data Transfer Service
- @neurENDO Messaging
- @neurLINK

Nationa

@neurIST bases its development on a

- service-oriented Grid infrastructure providing
- on-demand simulation, analysis and data-integration services
- handling multi-scale, multi-modal information at distributed sites.

Atom 10^{-12} m	Protein 10^{-9} m ProteinML	Cell 10^{-6} m CellML	Tissue 10^{-3} m TissueML	Organ 10^0 m AnatML	Organ system & organism PhysioML
Gene Networks	Pathway models	Stochastic models	ODEs	Continuum models (PDEs)	Systems models
10^{-6} s molecular events (ion channel gating)	10^{-3} s diffusion cell signalling	10^0 s motility	10^3 s mitosis	10^6 s protein turnover	10^8 s human lifetime

Source: Peter Hunter, Human PhysioML Project

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Research Institutes

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Certificate
Authority

Se

Global

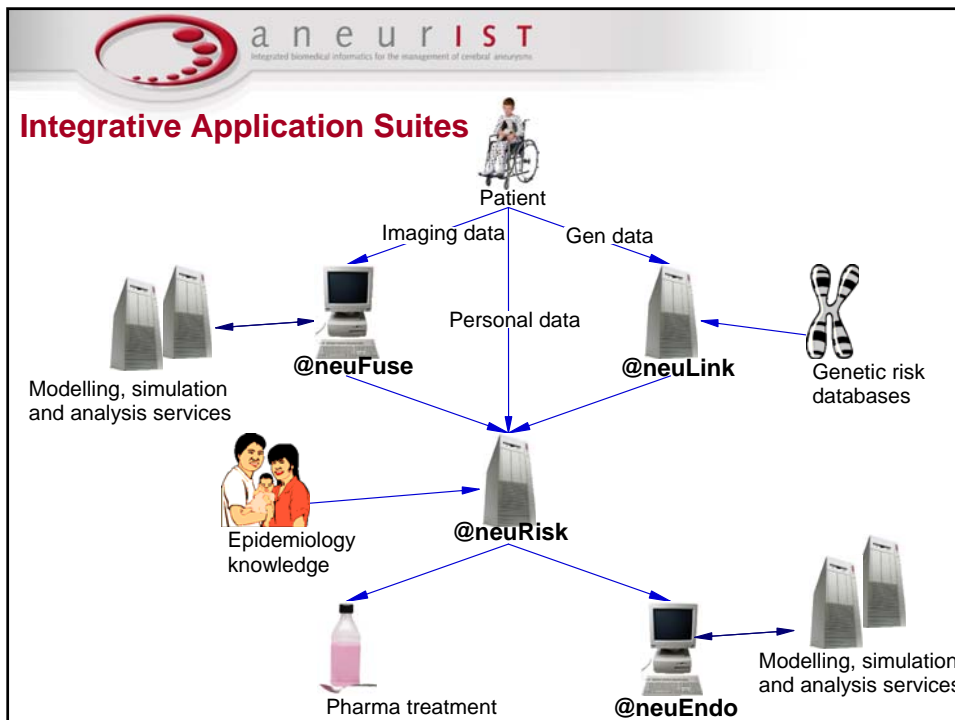
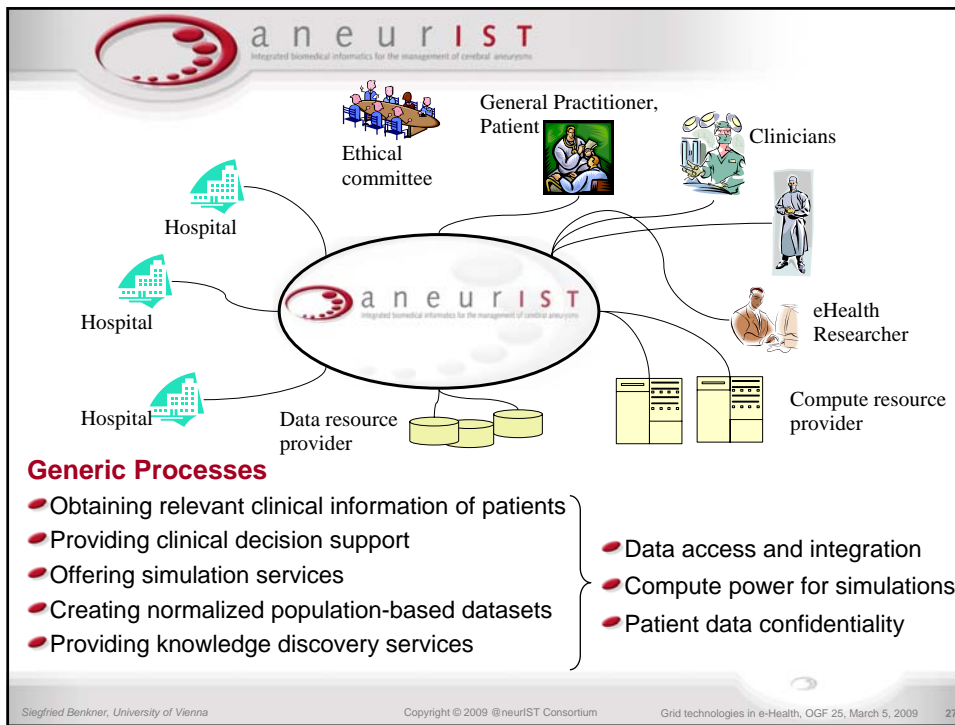
Data

Lo

Public DB

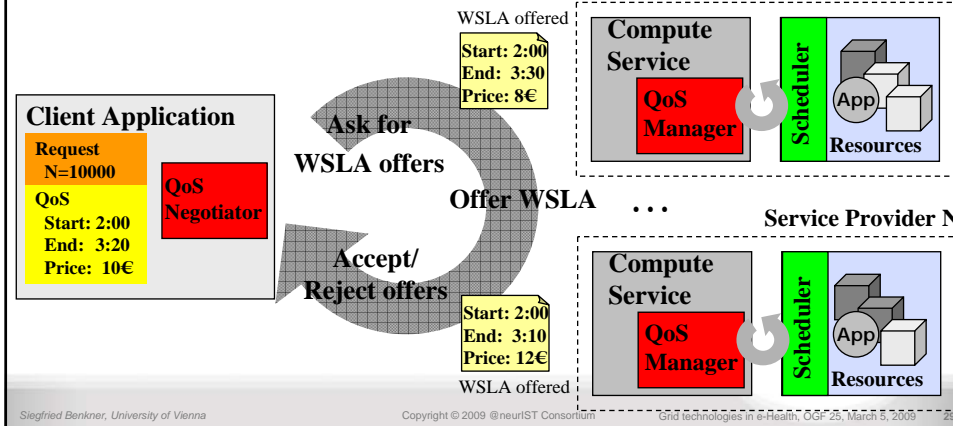
RA – Registration

@neurIST
Security/A
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SLA Negotiation and QoS

- Client-driven QoS negotiation with potential service providers
- Signed Service Level Agreement (WSLA) exchanged with winner
- QoS Negotiation: request/offer model, auction models, ...
- QoS Management: performance estimation, resource reservation, ...



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