S H A R E

Developing a **Roadmap** for a European **Healthgrid**

HealthGrid, overview of the State of the Art

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http://www.eu-share.org

The Share project (FP6-2005-IST-027694) is funded by the European Commission Information Society and Media DG under the 6th Framework Programme.

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- A perspective on the present use of grids for health
- Perspectives: challenges on the road to a wider adoption
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The concept of HealthGrid

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- Environment where data of medical interest can be stored, processed and made easily available,
- To different actors in healthcare
  - citizens,
  - physicians,
  - healthcare centres & administrations,
  - medical & biological research centres,
- With all necessary guarantees in terms of
  - security,
  - respect for ethics,
  - observance of regulations

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Why is HealthGrid a new approach to eHealth ?

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- Implementation of a new technology – Grid technology – to healthcare
- Involves changing mindset and workflows/operational/institutional/legal aspects
- Create common ground for all biomedical actors where to work on
- Opens up opportunities for new collaborative schemes in medical research and healthcare

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Situation in 2007: strengths & weaknesses

- International grid infrastructures available for scientific research
- But grid infrastructures have not entered into hospitals
- Grid toolkits offering grid services in a secure, interoperable and flexible manner (GT4, GRIA, ...)
- But they have not been tested at a large scale on biomedical applications
- Successful deployment of CPU intensive biomedical applications achieved world wide
- Very few applications involving manipulation of distributed biomedical data demonstrated so far
- Emergence of eScience environments like myGrid or VLe where bioscientists can manipulate their own concepts
- But these environments are not available on grid infrastructures

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A perspective on the present use of grids(1/2)

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- Use of grids for biomedical sciences
  - Life Sciences
    - To address complexity of databases interoperability (e.g. Embrace)
    - To ease the design of data analysis workflow (e.g. MyGrid)
  - Medical Research
    - To store and manipulate large cohorts of medical images (e.g Mammogrid)
    - To bring together and to correlate patient medical and biological data (e.g ACGT)
  - Drug Discovery
    - First step of a full *in silico* drug discovery process successfully proven (e.g. Wisdom)
    - To reduce time and save money in the drug discovery process

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Example n°1: BiG, BLAST in Grid

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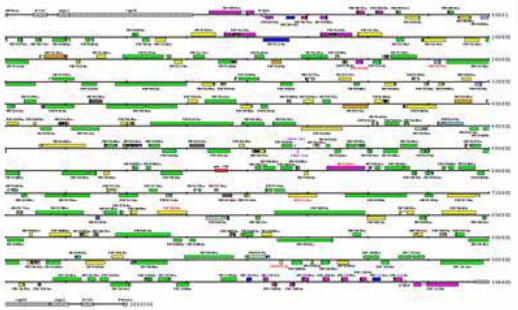
- **Scientific objectives**
  - Speed-up and Ease the use of a Well-known Application for Protein and Nucleotid Alignment.
  - Applications in Drug Development, Phylogeny, etc.
- **Method**
  - MPI-Blast.
    - Splitting of Input Sequences and Reference Databases into Multiple Jobs.
    - Deals with Multiple Databases Simultaneously.
    - Enhanced Security Through a MyProxy Server.
    - Fault Tolerant on the Client and Server Side.
    - Embeddable on a Stand-alone Application or Web Portal.
- **Status: Production in EELA.**
- **Contact:**



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Example n°2: OpenGATE

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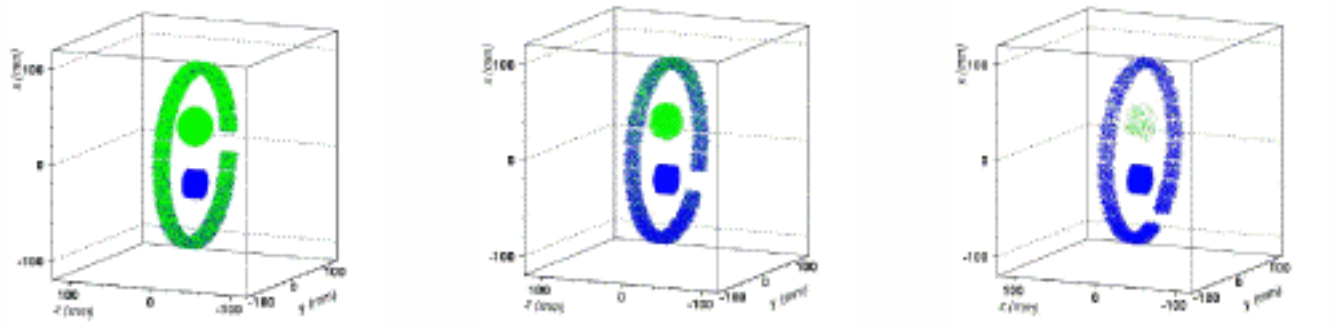
- Geant4 Application for Emission Tomography (GATE)
  - Simulation toolkit adapted to nuclear medicine
  - Innovative feature: inclusion of time-dependent effects

- Grid used to improve and speed simulation.
  - Requires Geant4: large, complex package.
  - Individual simulations not easily divisible.

Simulation of decay of O-15 (green) and C-11 (blue)



0-2 min | 7-9 min | 14-16 min

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Example n°3: WISDOM

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- WISDOM (http://wisdom.healthgrid.org/)
  - Developing new drugs for neglected and emerging diseases with a particular focus on malaria.
  - Reduced R&D costs for neglected diseases
  - Accelerated R&D for emerging diseases

- Three large calculations:
  - WISDOM-I (Summer 2005)
  - Avian Flu (Spring 2006)
  - WISDOM-II (Autumn 2006)

WISDOM
Initiative for grid-enabled drug discovery against neglected and emergent diseases

- WISDOM calculations used FlexX from BioSolveIT (3-6k free, floating licenses) in addition to Autodock.

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A perspective on the present use of grids(2/2)

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- Adoption of grids for healthcare
  - Still in its infancy…
  - For many good reasons
    - The technology is still rapidly evolving and providing new features. Although it is today not possible to implement a full stable operational system as changes are still expected, first implementations can be done and updated providing a primary set of functionalities.
    - All grid infrastructure projects are deployed on national research and education network which are separate from network used by healthcare services.
    - Legal framework in EU member states which has to evolve to allow the transfer of medical data between member states

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Example n°1: Pharmacokinetics (UPV)

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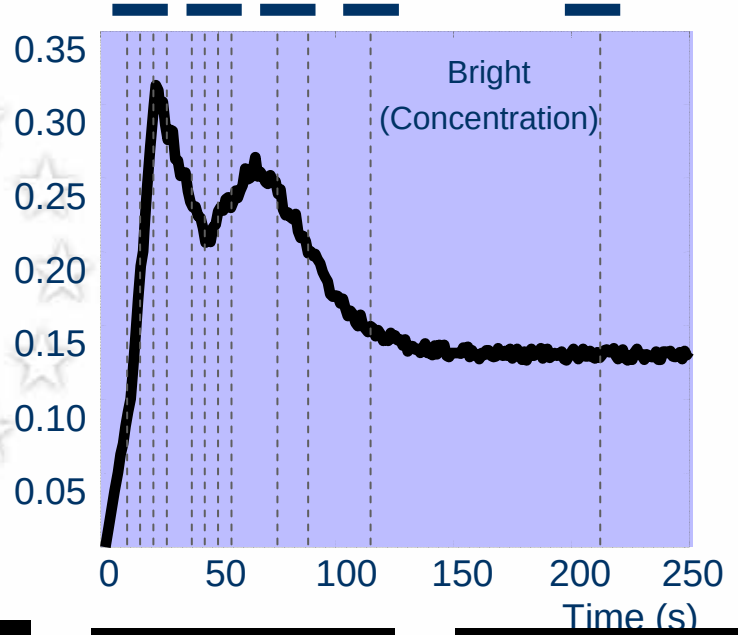
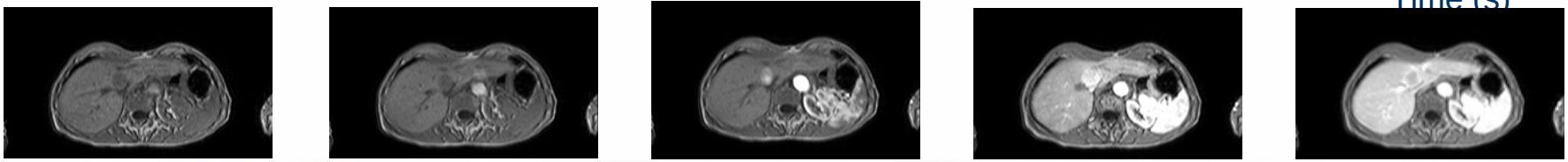
- Pharmacokinetic modeling of blood perfusion:
  - Technique provides quantitative assessment of angiogenesis
  - Angiogenesis is important marker for aggressiveness of tumors
  - Time-series of images allows measurement of model parameters
- Computationally intensive
  - Images must be aligned
  - Elastic organs make job harder





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Pharmacokinetics Results

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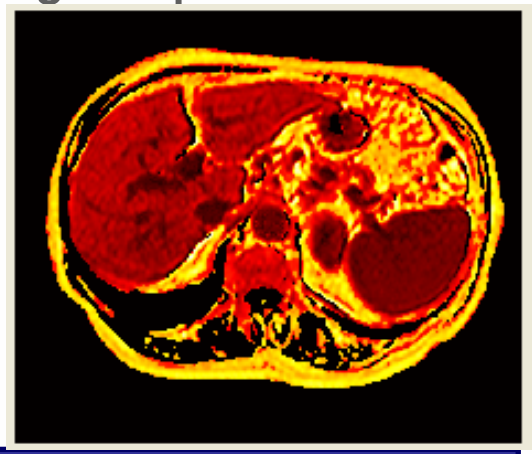
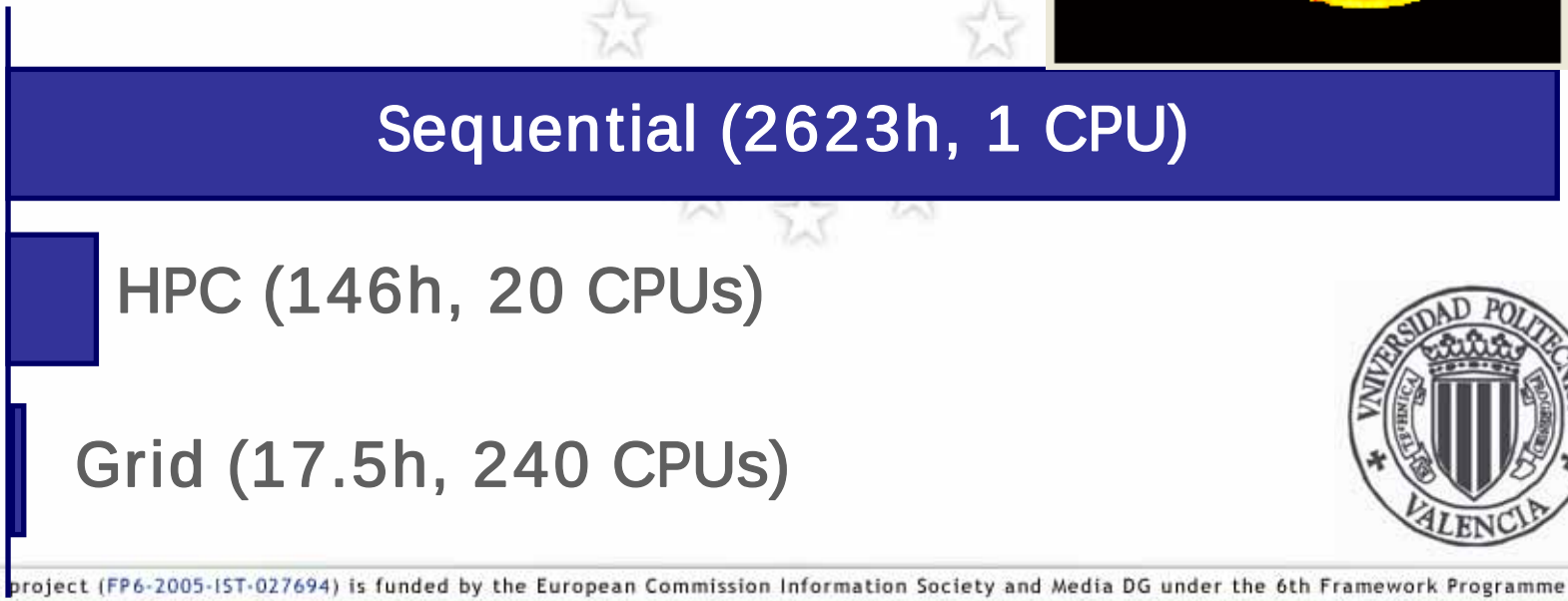
- Computing costs for a study involving 20 patients.
  - Significant reduction in real time:
    - Faster research results
    - Could imagine use in clinical setting
  - Understand tumor aggressiveness and response to therapies





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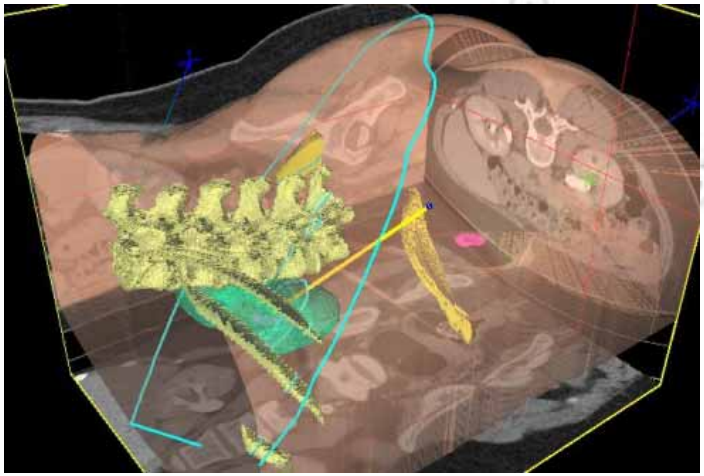
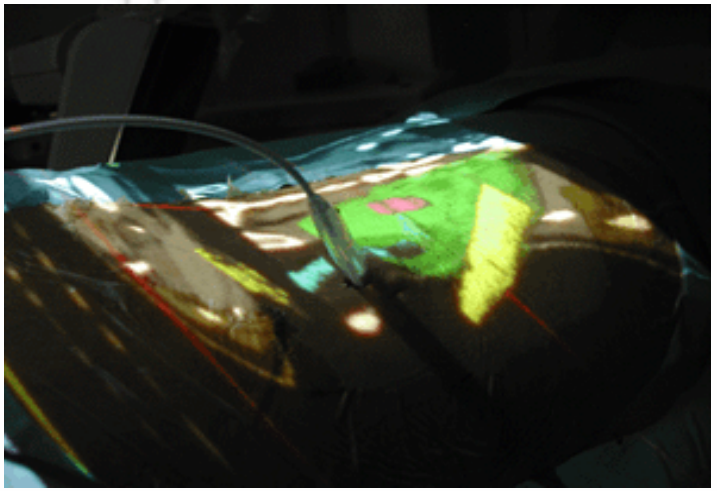
Example n°2: gPTM3D (LAL, LRI)

- PTM3D:
  - Interactive analysis of 3D data for surgery planning and volumetric analysis.
  - Requires “guiding” from physician to find initial contours, work around noisy data, …
  - Needs unplanned, interactive access to significant computational resources.





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Results

- Speed-up gives response times acceptable to doctors.
- Grid overhead doesn't dominate for short calculations.
- Requires application modifications to use with grid.

	Dataset (MB)	Input (MB)	Output (MB)	Tasks	1 CPU (s)	EGEE (s)
Sm. body	87	3	6	169	315	37
Med. Body	210	9.6	57	378	1980	150
Lg. Body	346	15	86	676	1080	123
Lungs	87	0.4	2.3	95	36	24

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Perspectives: the challenges on the road to a wider adoption

- Grid technology
- Grid deployment
- Standardization
- Communication

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Issues related to grid technology

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- No middleware fulfills yet all the requirements for life sciences and medical research
  - The ones which have demonstrated their scalability (gLite, Unicore) need additional functionalities e.g. in the area of data management
  - Some which offer powerful and demonstrated data management functionalities (SRB) have limited job management services
  - The previous middlewares are not so far built on web services and therefore do not offer standard interfaces
  - More recent grid middlewares based on web services have not yet demonstrated their robustness and scalability
- Large scale deployments only achieved by experienced groups

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Deployment issues

- Very limited deployment of grid nodes in healthcare centres and biological laboratories
- Need for functionalities allowing secure manipulation of medical data
- Need for an easy to install middleware distribution
- Need for friendly user interfaces to the grid for non experts

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Standardization issues

- definition and adoption of international standards and interoperability mechanisms is required for storing biomedical information on the grid
- Examples in the world of health
  - standard for the exchange of medical images on the grid based on DICOM
  - standard for the exchange of Electronic Health Records on the grid
  - Standard for recording and ensuring consent
  - Standards for anonymization and pseudonymization
- Beyond standards, agreed ontologies are also needed
  - Good example: gene ontology in genomics
  - Very long way to go particularly in medical informatics

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Communication issues

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- Grids are vaguely known to the bioinformatics and medical informatics community
- Grids are mostly unknown to the biology and medical community
- Reaching out these communities requires dedicated efforts
  - Need for success stories demonstrating the impact of grids for biomedical research
  - Prerequisite: grids must become a serious alternative to the existing computing models
  - CPU crunching is not sufficient

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Proposed actions for a wider adoption

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- Develop reliable grid services fulfilling (legal) biomedical requirements notably for data & knowledge management
- Define and adopt European / International standards and interoperability mechanisms for the sharing of medical information on grids
- Integrate healthcare centres in the existing grid infrastructures
  - hospitals, medical research laboratories and public health administrations
- Promote the creation of one or several dedicated infrastructure
  - biomedical research in a first step

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NGG3

Next Generation Grids Report 2005

Future for European Grids: GRIDs and Service Oriented Knowledge Utilities – Vision and Research Directions 2010 and Beyond, December 2006

Service-Oriented Knowledge Utility (SOKU)

A flexible, powerful and cost-efficient way of building, operating and evolving IT intensive solutions for business, science and society.

- **Building on existing industry practices and emerging technologies**
- **Support ecosystems that promote collaboration and self-organisation**
- **Towards increased agility, lower cost, broader availability of services**
- **Empowering service providers, integrators and consumers of ICT**
- **(R)evolution of concepts from Web, Grid & Knowledge technologies**
- **Safe, ease and ubiquitous as existing utilities like electricity or water**

NGG3

Service-Oriented Knowledge Utility

The architecture comprises services which may be instantiated and assembled dynamically, hence the structure, behaviour and location of software is changing at run-time

Services are knowledge-assisted ('semantic') to facilitate automation and advanced functionality, the knowledge aspect reinforced by the emphasis on delivering high level services to the user

A utility is a directly and immediately useable service with established functionality, performance and dependability, illustrating the emphasis on user needs and issues such as trust

Toward a HealthGrid roadmap

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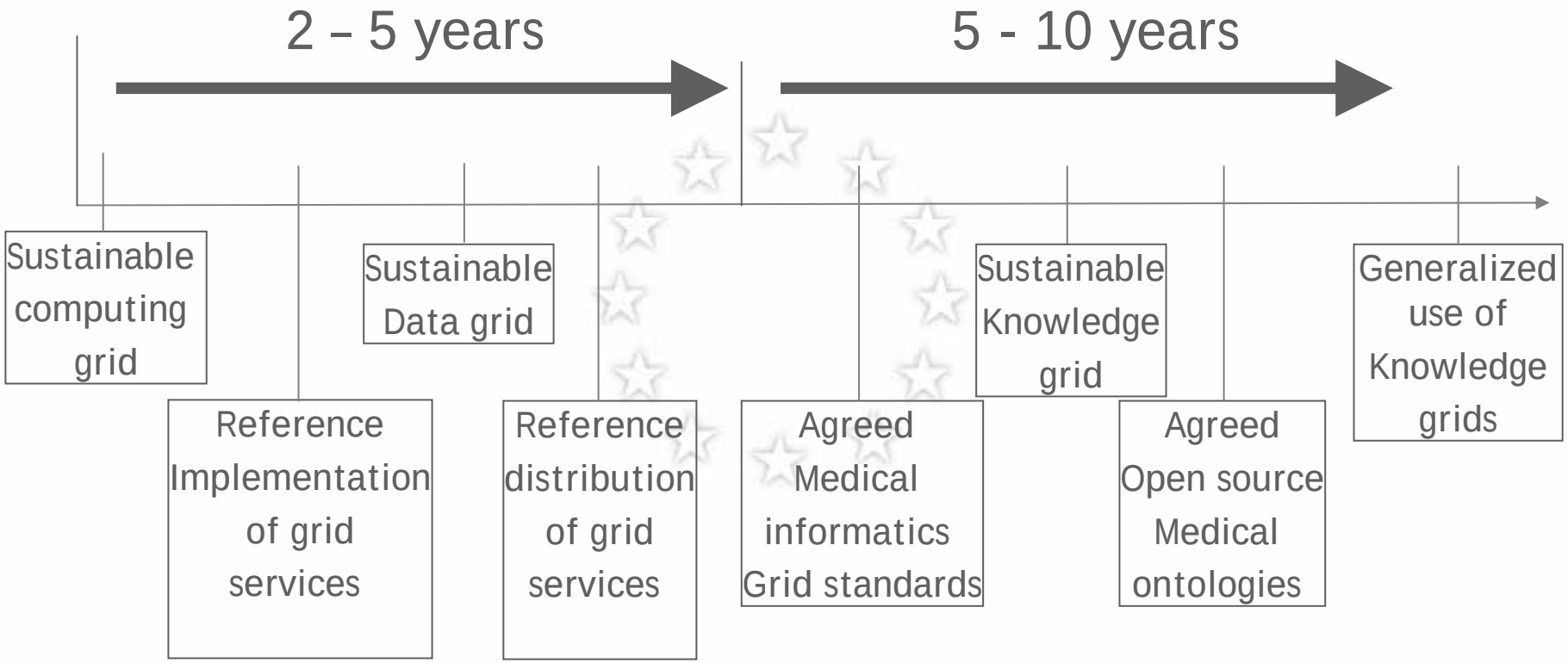
Share: 2 year project (2006-2007) funded by EU to produce a roadmap for HealthGrid adoption



www.eu-share.org/deliverables.html

discussions on http://wiki.healthgrid.org

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A Knowledge Base on healthgrids

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- To create a comprehensible compendium of all projects and initiatives related to the development or use of grid technology for healthcare and biomedical research as well as their applications.
- Empower the projects by favouring re-use of components already developed
- Allowing people to find from a single entry point all relevant information related to the above mentioned topics including
  - an up-to-date database about projects and institutions/people involved,
  - a digital library offering access to the appropriate literature
  - the latest burning discussions and debate and offering the opportunity to contribute
  - the latest pieces of code developed as well as the latest collaborative projects where to contribute in
- We ask you to contribute to help us making this powerful tool a reality for the benefit of the whole community, you first!
- One single entry point: www.healthgrid.org

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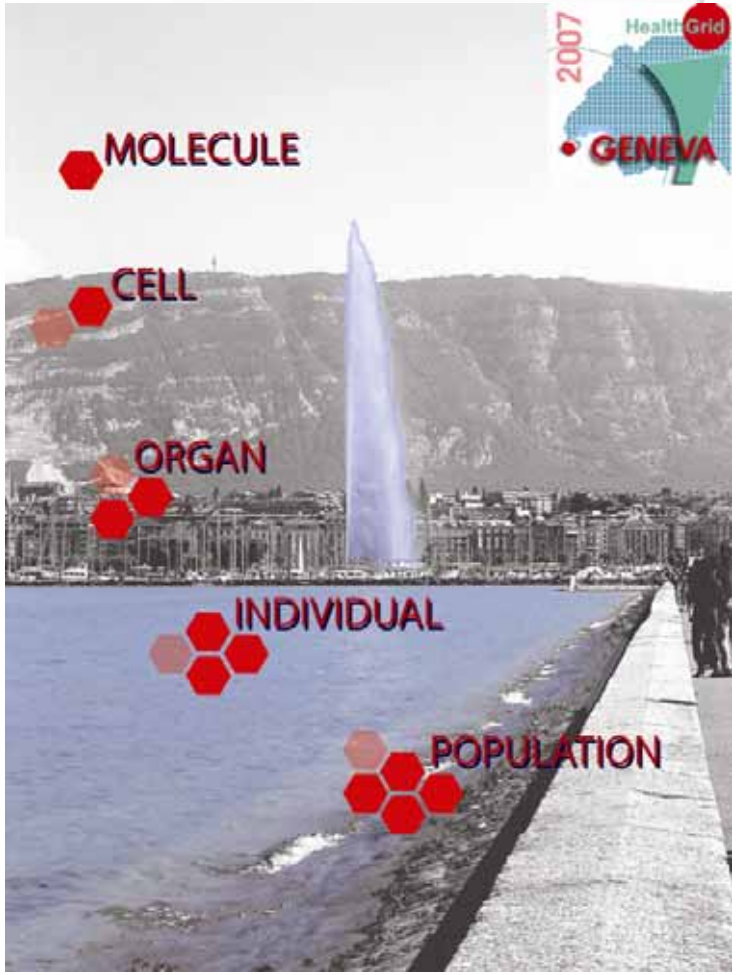
HEALTHGRID 2007

April 24th-27th

Geneva, Switzerland



http://geneva2007.healthgrid.org

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