Grid TALK
GridBriefings
Grid computing in five minutes

The Future of Healthcare: eHealth and Grid Computing

From a patient's heart monitor to electronic health records, eHealth has integrated itself into all aspects of healthcare. Grid computing is playing a key role in this growing area, providing storage and computing power for initiatives in several biomedical disciplines. These tools enable researchers to investigate diseases and rare conditions, as well as providing doctors with new ways to diagnose and treat patients. And by integrating the vast amount of medical data available, they could herald the beginning of personalised treatments for patients.

Together, eHealth and grids are shaping the future of healthcare. This briefing examines some of the key eHealth projects in Europe, looks at the challenges involved and presents opinions from experts in the field.

The i2010 vision

The i2010 strategy is the EU policy framework for information society and media. Running from 2005 to 2010, it aims to:

1. establish a **single European information space**
2. reinforce innovation and investment in **ICT research**
3. promote **inclusion, public services and quality of life**

Credit GridTalk

Safeguarding Europe's health

Information and Communication Technologies (ICTs) are becoming more integrated into our lives, and healthcare has proved no exception. For clinicians, researchers and patients, eHealth is making healthcare more efficient, accessible and personalised.

Since the early 1990s, the EU has invested more than €500 million in the development of eHealth tools and systems. Consortiums such as the Assembly of European Regions e-He@lth Network work together with policy makers, medical personnel and IT experts to further eHealth. And, due to a heavy emphasis on ICT research and improving public services, the EU's i2010 strategy (see box) has ensured that the subject has been firmly on Europe's agenda.

Grids for healthcare

Grid computing allows users to share computer power and data storage capacity over the internet. Today grids facilitate work done in many areas of healthcare, with initiatives such as HealthGrid working with both clinicians and researchers to promote awareness of the advantages linked to deploying grid technologies.

Grid technologies are being used in many areas:

- Researchers can use grid computing's processing power to hunt for new viruses, search for new drugs, model disease outbreaks, image the body's organs and determine treatments for patients
- Doctors can gain access to relevant health data regardless of where it is stored
- Patients can receive a more individualised form of healthcare
- Healthcare workers are better able to collaborate and share large amounts of information

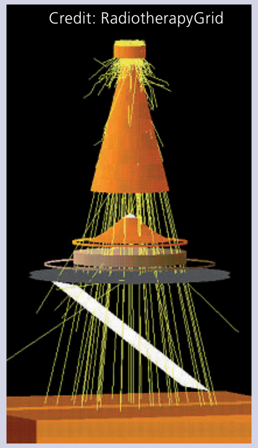
Samuel Keuchkerian, HealthGrid - *"Enhancing the capacity of the bioinformatic and medical communities with the power of grids and clouds provides the opportunity for new fields of operations where diagnosis, drug discovery, exchange and monitoring of health related data will become increasingly fast, accurate and easy to handle. Healthgrids are the right innovation for health professionals to use applications saving time, money and allowing an increase in scope and results that could not be provided through traditional IT services. Grids and clouds are therefore the future for medical and biomedical applications"*

Putting health on the grid

Grid computing is perfect for research that requires large numbers of parallel computations, and so is a lifeline for biomedical projects with growing processing needs that otherwise would be extremely difficult to meet. Work that could take months without a grid can take only hours. In the lab, the grid has helped researchers to discover new viruses and to study the heart's response to defibrillation. Grids are also well placed to enable image processing. Producing images is a computer intensive but essential task that helps clinicians visualise organs in the body for disease, damage or irregularities. Grid computing is the workhorse behind imaging tools such as the GLOBE Genome 3D Browser (see box) and HemeLB, which allows doctors to view a 3D representation of a patient's brain, giving them detailed information when it comes to planning neurosurgery.

Grid-enabled treatment: RadiotherapyGrid

Every year 3.2 million Europeans are diagnosed with cancer. One of the most common and effective techniques for treating the disease is with external radiotherapy, but calculating the process for delivering the prescribed doses can be a lengthy task.


Credit: RadiotherapyGrid

RadiotherapyGrid uses grid technology to speed up the calculations, providing new services to plan the best possible treatment for each patient. The tool can help in complex cases to improve the treatment quality or to find suitable treatment plans. As well as ensuring the data is fully secure, RadiotherapyGrid shows how grid technology can be used to quickly provide more accurate treatments for cancer patients and save hospitals money.

For pharmaceutical companies, grid technologies can move drug discovery from the lab to the computer, saving money when developing potential new drugs.The WISDOM initiative, which relies on the Enabling Grids for E-sciencE (EGEE) infrastructure, has taken this approach, using the grid to find strong drug candidates for malaria. As a disease that offers pharmaceutical companies little chance of profit, malaria is often neglected, but the grid can provide an ideal and cheap platform on which to base further research.

Healthcare spanning borders

Grid technology can break down barriers between healthcare systems in different countries by providing a homogeneous way to efficiently store, exchange and access medical data in a secure manner. This could potentially lead to EU citizens having access to both their medical data and treatment no matter where they are on the continent.

A clearer view: Using the grid to image DNA?

When analysing DNA, problems abound due to the massive amounts of data involved. Researchers might have to work with up to 10 million markers on a DNA strand, which is very time consuming without a supercomputer or grid.

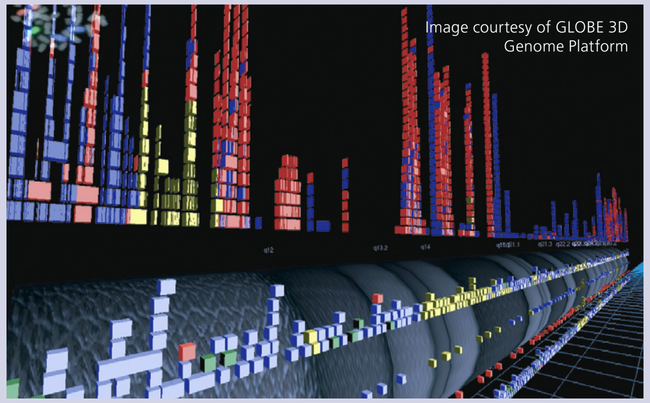


Image courtesy of GLOBE 3D Genome Platform

Finding a way to represent this genomic information in a visual form, and to reveal its scientific meaning, is a major challenge. The GLOBE 3D Genome Platform answers the question - how do we view this data in order to analyse it further? This browser acts as a virtual desktop behind which the grid enables researchers to both visualise and analyse DNA sequences.

"The GLOBE 3D Genome Platform allows us to visualise, for the first time, genetic information with respect to the 3D architecture of the genome in the cell nucleus," says Tobias Knoch who is leading the project. "We have created the first tool which integrates genomic complexity in an easy to use and understand platform - a 'Google Maps' for genetic information if you will!"

Ken Buetow, National Cancer Institute, caBIG - *"I think grids and bioinformatics are transformative technologies - they represent an opportunity to connect the disparate components of healthcare, medicine and biomedical research. Grid and e-infrastructures give people access to data and/or analytic capabilities that they otherwise wouldn't have. On the other hand it also provides them with capabilities to manage their own data, to connect that data with other people's, to share results and to form collaborative teams and virtual organisations."*

Integrating the healthcare systems of many countries is a major task, requiring new sets of standards, and solutions to issues related to communicating medical data across borders. Initiatives such as ACTION-Grid hope to create a common health information infrastructure in Europe, and extend it to other regions by working with research centres, universities, hospitals, SMEs and public entities.

Despite these difficulties, discipline-specific grids now connect researchers and clinicians across the globe. For instance, US-based caBIG, the cancer Biomedical Informatics Grid, works to provide a collaborative information network for

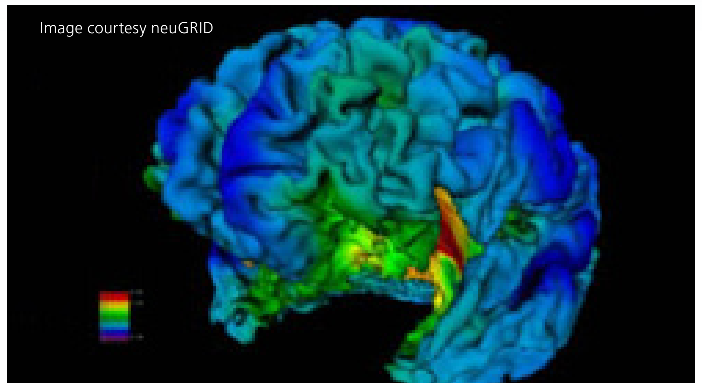


Image courtesy neuGRID

cancer research. Their mission is to accelerate the discovery of new approaches for the detection, diagnosis, treatment, and prevention of cancer, ultimately improving patient outcomes. Similarly, the EU-funded project neuGRID provides neuroscientists with an advanced e-Infrastructure to develop and clinically assess new imaging markers of neurodegenerative diseases. The project assists in the diagnosis of these types of diseases while also delivering a series of generic biomedical utilities which can be reused across the life sciences.

Privacy and consent

Grid technology can offer the field of medicine numerous benefits, but its application to healthcare is not straightforward. The SHARE project (Supporting and structuring HealthGrid Activities & Research in Europe), which concluded in 2008, addressed this issue and produced a roadmap that identified major challenges on the road to the widespread deployment of healthgrids.

Among the issues raised by SHARE were those concerning security, data protection and privacy. Many grid-based eHealth initiatives involve the storage of large amounts of patient data that must be kept in an accessible but secure manner, and must abide by data protection laws. eHealth initiatives must be designed with this in mind, and services provided to anonymise data. However with care, healthgrids can overcome these issues. RadiotherapyGrid (see box), used in the treatment of cancer patients, ensures the data is fully secure by using security tools built into EGEE that only authenticated users have access to.

Patient consent will also be of vital importance when dealing with data about identifiable individuals in healthgrids, as in other areas of healthcare. Patients should be fully informed about who will have access to their records and how they will be used. Well-defined research can cope with these restrictions and initiatives such as @neurIST and Health-e-Child successfully use patient data to improve treatments.

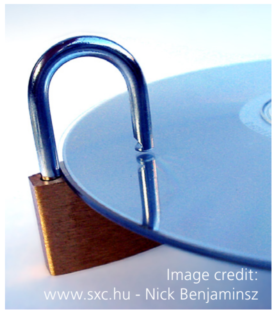


Image credit: www.sxc.hu - Nick Benjaminsz

Although SHARE has now ended, these issues have not been forgotten, with permanent policy bodies such as the e-Infrastructure Reflection Group (e-IRG) taking them on board. At the May e-IRG workshop held in Prague this year, medical privacy and data-related issues were both high on the agenda.

Giovanni Frisoni, The Italian National Centre for Alzheimer's and Mental Diseases - *"Grids as we currently use them can be of great help when developing drugs for chronic diseases. For Alzheimer's disease, for example, we do not have an objective marker to find out if a drug works or not. The grid can be instrumental to help us to develop image based markers, such as how the cortical mantle in the brain thins over time. This can help us track the disease and therefore monitor the usefulness of drugs in small numbers of patients, over short periods of time."*

Martin Hofmann-Apitius, The Fraunhofer Institute - *"eHealth has a lot of potential, but what we have to keep in mind is that we have to be prepared to go a long, long way with it. The health community is hundreds of thousands [of people]. Even in eHealth there are still a lot of people, much more than, for example, in high energy physics. Therefore finding a common understanding is more difficult - and there's privacy, and legal and ethical considerations which make things much more complicated."*

The personal touch

A major European initiative, the Virtual Physiological Human (VPH) is working to assemble a model that will allow investigation of the human body as a single complex system. From the molecular and cellular level, to organs, and finally the whole individual, the initiative will integrate biomedical research across disciplines. The aim is to create a computer model which can be used to simulate conditions and treatments of individual patients; providing a way to personalise healthcare.

VPH is a huge undertaking that could give us vast prediction abilities about human functionality. However assembling such a complex model requires a large amount of computing power and also places a huge demand on data storage and management. Because grids allow researchers to easily store and share data with each other, they are already playing a crucial role in VPH projects such as Health-e-Child and @neurIST.

VPH projects range from those developing computational models of the heart and predictive models for dementia, osteoporosis and drug safety, through to projects furthering a common health information infrastructure to facilitate easier access to European supercomputing power. They require a wide variety of resources - from the supercomputing network DEISA to EGEE clusters.

"VPH proposes a new dimension in the integration of scientific fields towards improvement of human health - it uses computing power to reshuffle disciplinary boundaries and translate knowledge production into societal benefit," says Miriam Mendes, VPH Project Coordinator.

A collaborative approach

For healthgrids to be truly effective, grid researchers and physicians need to work closely together to understand each other's needs. As the SHARE roadmap states: 'It is important that technical research and development be conducted in close collaboration with user communities.'

With new technologies also comes the need for training. Grid applications for eHealth must be designed for ease of use and in some cases developers may even want to 'hide the grid' to provide accessible interfaces. Initiatives such as Health-e-Child are leading the way, providing doctors with services that have real benefits but are also easy to use.

Joël Bacquet, European Commission *"Most biomedical researchers, involved in the Virtual Physiological Human initiative (see box), will need an access to a computational grid of some sort. Biomedical datasets need to be processed on high-performance computing facilities due to the size of the generated data. Researchers will also need to access and/or transfer large sets of data around grid infrastructures. However the barrier to entry seems still to be high as few researchers are using resources other than their local ones mainly due to accessibility and usability issues."*

The fight against influenza: A global task

Countries across the globe have been fighting the recent swine flu pandemic with quarantining, antivirals and calls for good hygiene. However, researchers hope to add a new weapon to their arsenal if another pandemic strikes: the grid.

Grid technology can monitor the spread of a disease, providing decision-makers with vital information for a public health response. Using the computing, storage and automatic updating services offered by grids, researchers can dynamically analyse the molecular biological data available on public databases. In this way, they can track mutations on the virus genome that could impact the way the virus is transmitted, causes disease and is affected by drugs.

"Everyone is aware and, in some way, is scared of what is occurring worldwide with the flu pandemics," says Ana Lucia Da Costa, of HealthGrid. "Global health initiatives are needed to monitor such a threat. Grid permits us to federate all molecular data related to the disease and to process them automatically. Grid offers real-time in silico results which are very useful for experts' decisions concerning detection, evolution and treatment of such a viral infection."

Grids for kids: Improving paediatrics

Coughs and colds are common childhood illnesses, but rarer disorders are much harder for doctors to diagnose and treat. Health-e-Child is remedying this problem by providing new tools for paediatricians to treat their young patients.

Credit: Health-e-Child

The project uses a grid-based platform to enable clinicians and researchers to store, retrieve and manipulate medical records. Using this infrastructure, the CaseReasoner application, for example, allows doctors to search for similar conditions from anonymous patient records, giving them reassurance and help when treating rare diseases.

"Regardless of their location and thanks to a simple USB stick, physicians are able to seamlessly connect and navigate through the European population of children enrolled in their studies" says David Manset from the project. "Three years of intensive work were required to deploy this large grid network and to develop innovative new models addressing physicians' hypotheses."

A total of 15 institutions across Europe, including four hospitals, are participating in the Health-e-Child project. Its other applications include modelling and advanced imaging in cardiology, rheumatology and neuro-oncology, giving doctors a greater knowledge of how to treat children with heart conditions, juvenile arthritis and brain tumours.

For more information:

Europe's Information Society Thematic Portal: ICT for Health http://ec.europa.eu/information_society/ehealth

HealthGrid: www.healthgrid.org

Share roadmap: http://roadmap.healthgrid.org

Virtual Physiological Human NoE: www.vph-noe.eu

Health-e-Child: www.health-e-child.org

neuGRID: www.neugrid.eu

RadiotherapyGrid: www.beingrid.eu/radiotherapygrid.html

@neurIST: www.aneurist.org

iSGTW: www.isgtw.org

EGEE (Enabling Grids for E-sciencE): www.eu-egee.org

GridTalk : www.gridtalk-project.eu

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