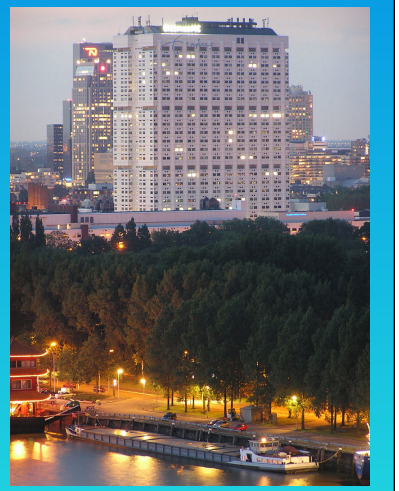
Resource Sharing at the Tera-FLOP Scale

For the BioMedical Research & Care Sectors

The Erasmus Computing Grid & MediGRID



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The Erasmus Computing Grid

The largest desktop grid for the biomedical research and care sectors with now ~10 Tera FLOPS and a potential ~30 Tera FLOPS and ~15,000 desktops, at two city wide institutions: the Hogeschool Rotterdam and the Erasmus Medical Center.

Research:

- genomic and proteomic analysis
- epidemiology
- image analysis, e.g. Applied Molecular Imaging (AMI)

Education:

- training of the coming grid generation of IT specialists
- developing new concepts for grid computing

Diagnostics:

- clinical image and data analysis
- operation planning and operation support

Industry:

- brokerage of computing resources

Dedicated and Secured!

MediGRID and Services@MediGRID

MediGRID and Services@MediGRID operate the national biomedial research and care cluster-grid within the national German D-Grid initiative and integrate various disciplines, institutions, and states throughout Germany.

Erasmus Computing Grid

Erasmus MC

HOGESCHOOL ROTTERDAM

~ 20 BioMedical User Groups

Distributed - Office

~ 20 D-Grid Communities

~ 100 D-Grid Donor Organizations (~10 MediGRID)

~10,000 Cluster Nodes

~ 2,000 Medical Secured

Module Coordination:
- coordination of the distributed office

Module Resource Integration:
- sharing of the integrated resources

Module Middleware:
- grid technical virtualization

Module Ontology Tools:
- ontology development for grid user projects

Module BioMedical Informatics:
- user projects in biomedical research

Module Clinical Imaging:
- user projects in clinical imaging

Module Clinical Research:
- user projects in general clinical research

Module e-Science:
- general research on e-grid science

Services@MediGRID:
- services towards MediGRID

Dedicated and Secured!

Large-Scale Resource Sharing in IT:

The *Inverse* Tragedy of the Commons

Erasmus Computing Grid

The grid phenomenon and its implications are similar complicated to the ecology/climate/environmental challenge!

The Tragedy of the Commons:

=> A resource belonging to all and being on limited demand is overexploited / destroyed by the users due to responsibility diffusion!

<= transforms into =>

:The *Inverse* Tragedy of the Commons

A Resource belonging to all and being in affluent availability on limited demand is <= *underexploited* by potential users due to responsibility diffusion !!!!!

Similarity: Renewable Energy Resource!

The grid challenge lies in the e-Social embedding of grid phenomenons:

- **Micro-Sociality: the sharing attitude and socialization of the individual.**
- **Macro-Sociality: the organization culture of the embedding institution.**

Autopoietic Social Sub-Systems:

The Grid Challenge of Integration

The social systems theory by Niklas Luhmann (1927-1998) based on the autopoietic concept of Humberto Maturana and Francisco Varela (1946-2001) is so far the most advanced social systems theory existing to describe the complexity of grid implementation.

The Social Sub-Systems Involved:

- **Religion**
- **Education**
- **Science** **=> currently grid involves only considerably => SCIENCE**
- **Art**
- **Economy**
- **Jurisdiction**
- **Policy**

:The Autopeitic Tragedy of Social Sub-Systems

The subsystems have their own code of communication and are separated from each other in a way blocking in principle a consistent integration although they form a society with all their contradictions !!!!!

The e-Social challenge lies in the integration of sub-systems towards a working grid society:

- **Micro-Sub-Systems: the sub-system stickiness of individuals.**
- **Macro-Sub-Systems: the integration of institutionalized sub-systems via soft interfaces.**

Grid Psychology

From Individual to Cultural Risk Management

Grid implementation and social spread is carried first by individuals as with any meme introduced into society: in the focus of the transformation of society to e-Society stands - as always - the balance between potential risk and opportunity.

linking grid psychology with autopoietic social sub-systems

The Risk Psycholgy Matrix:

- **Individual Security Perception & Risk Acceptance**
- **Knowledge-Based Security & Risk Acceptance**
- **Incidental Security Reaction Behaviour**
- **Legal and Political Security Scenarios**
- **Religious & Cultural Security Archetypi**

:The Autopoietic Link

Genetics & Deep Psychology (C.G. Jung)

Education & Science

Economics & Realities

Jurisdiction & Politics

Religion, Art & Culture

The grid challenge lies in a unified concept addressing the psychology of grid:

- **Micro-Risk-Management: the micro-risk in the perception the individual and its emotional well-being.**
- **Macro-Risk-Management: the macro-risks in the procedural and institutionalization in organizations.**

e-Human *"Grid"* Ecology

Overcoming of the "Dare-To-Share" Attitude

The success of grid is based on a sustainable grid ecology within the e-Society, i.e. the e-Human Ecology of Grid reaches a equilibrated space within the integration of grid psychology with autopoietic e-Social sub-systems. Human Ecology first evolved in Chicago in the 1920's in the area of city development by Robert Park (1864-1944) and Ernest Burgess (1886-1966).

The Definition of e-Human "Grid" Ecology:

"Under e-Human "Grid" Ecology we understand the complete science of the relationships of grid to the surrounding environment to which we can count all conditions of existence in the widest sense."[1]

[1] Haeckel, E., Generelle Morphology der Organismen, Berlin, Band 2, Allgemeine Entwicklungsgeschichte, p. 286, 1866.

[2] Haeckel, E., Natürliche Schöpfungsgeschichte, 9. Auflage, Berlin, p. 793, 1898

(e-Human "Grid" Ecology "is) …the relationship between grid and all other e-Social systems." [2]

=> Solution to the Inverse Tragedy of the Commons!

The solutions of the grid challenge on the operational layer are addressed by:

- **Micro-Operationality: the participative integration of fundamental IT applications of major individual users complying with the psychology of grid in an e-Human Ecology manner.**
- **Macro-Operationality: the set-up of an open and sustainable management structure complying to all the autopoietic e-Social sub-systems in an e-Human Ecology manner.**

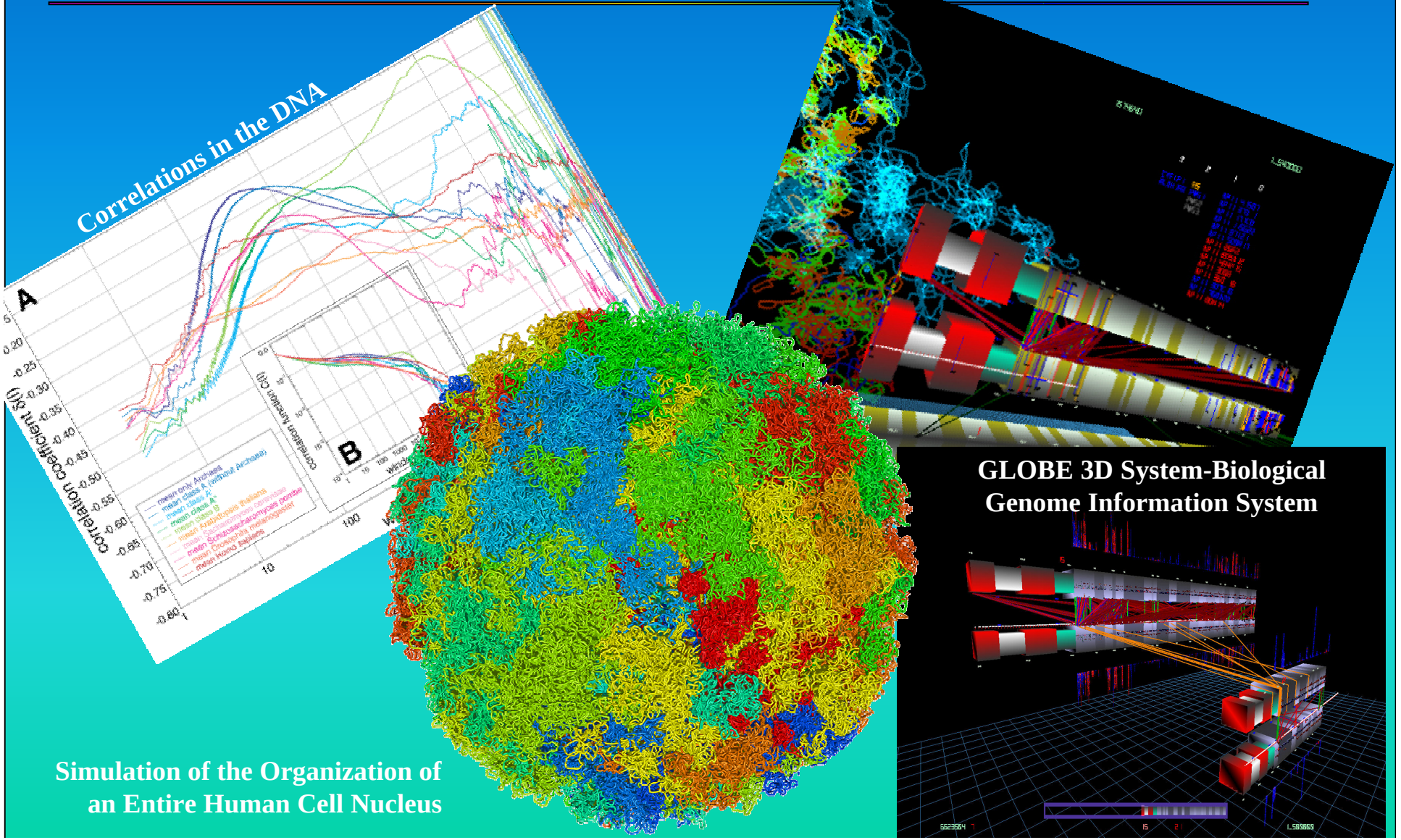
The Happy End - Profits Sharing the Commons

Both the Erasmus Computing Grid and the MediGRID/Services@MediGRID examples show that the IT challenges mankind faces in the biomedical research and care sectors can be successfully approached by exploitation of the commons by e-Human "grid" Ecology means.

Erasmus Computing Grid

Erasmus MC

HOGESCHOOL ROTTERDAM



GLOBE 3D System-Biological Genome Information System

Simulation of the Organization of an Entire Human Cell Nucleus

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Ressource-Sharing on the Tera-Flop Scale for the Biomedical Research and Care Sector

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The Erasmus Computing Grid and MediGRID

Knoch, T. A.

HealthGRID 2008. Gleacher Center, Chicago, Illinois, USA, 2nd - 4th June, 2008.

Abstract

Today advances in scientific research as well as clinical diagnostics and treatment are inevitably connected with information solutions concerning computation power and information storage. The needs for information technology are enormous and are in many cases the limiting factor for new scientific results or clinical diagnostics and treatment. At the same time huge computing and storage resources (e.g. ~10^9 personal computers in the private, public, and industrial domains) have been installed which outwheigh the resources at high-performance computing centers ~50-100 times and thus could contribute to the challenges mankind faces. Both the Erasmus Computing Grid (ECG) and the MediGRID are two major working resource-sharing entities at public funded organizations:

i) The ECG in Rotterdam exploits currently the desktop computers of the Erasmus Medical Center (the biggest biomedical research and hospital center in The Netherlands) and the Hogheschool Rotterdam (one of the biggest city universities in The Netherlands) and consists of ~10^4 hosts with ~ 10 TeraFlops capacity (30 TeraFlops at the end of 2008). The ECG has grown into a vital part of the work of the ~10 user groups as well as the organizations, with results which could not have been done without the ECG.

ii) The MediGRID being part of the German D-Grid initiatives connects local dedicated cluster resources at biomedical universities throughout Germany with a capacity of ~2000 hosts with ~2 TeraFlops capacity. Within MediGRID ~15 user groups conduct basic research as well as clinical applications for diagnosis and treatment. Again the results could hardly be obtained otherwise and thus have provided breakthroughs.

To build these infrastructures two e-social influences had to be overcome: i) the sharing attitude and socialization of the individual, i.e. the micro-sociality, and ii) the organization culture of the embedding institution, i.e. the macro-sociality, as e.g. for the ECG the public funded organizations. Operationally, an these factors were adressed by: i) the participative integration of fundamental IT applications of major users, and ii) the setup of an open and sustainable management structure.

Consequently, we show that the IT challenges mankind faces in the biomedical research and health-care sectors can be successfully approached by appropriate exploitation of the huge

existing resources by grid technology combined with micro and macro e-social means to stimulate sharing on the individual as well as organizational level.

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Keywords:

Human ecology, e-human grid ecology, society, social systems, e-social challenge, inverse tragedy of the commons, grid phenomenon, parallel super computing, grid computing, volunteer computing, micro-sociality, macro-sociality, autopoietic tragedy of social sub-systems, micro subsystems, macro subsystems, micro operationality, macro operationality, grid psychology micro riskmanagement, macro riskmanagement, information browser, visual data base access, holistic viewing system, integrative data management, extreme visualization, three-dimensional virtual environment, virtual paper tool.

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