Large-Scale Resource Sharing at Public Funded Organizations
e-Human *"Grid"* Ecologye-Human *"Grid"* Ecology

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Erasmus Computing Grid

Erasmus MC

HOGESCHOOL ROTTERDAM

Bundesministerium für Bildung und Forschung

Kirchhoff-Institute for Physics

MediGRID

Ruperto-Carola University Heidelberg

ECG

The Erasmus Computing Grid (ECG) is the largest desktop grid for the biomedical research and care sectors. The computers of Erasmus Medical Center and the Hogeschool Rotterdam are donated to the ECG and technically exploited using the middleware CONDOR and a newly developed management system. Currently, the ECG has an installed capacity of ~10 Tera FLOPS and ~10,000 computing cores available for user applications (total existing capacity: ~30 Tera FLOPS and ~30,000 computing cores, respectively). In absolute terms this is also one the largest dedicated computer resources world wide available to users via a central entry port managed by

Fig. 1: The main organization structure of the ECG is determined by the user groups which via the ECG centralized office have access to the desctop computers of the two donor organizations - the Erasmus Medical Center and the Hogeschool Rotterdam with ~15,000 PCs being

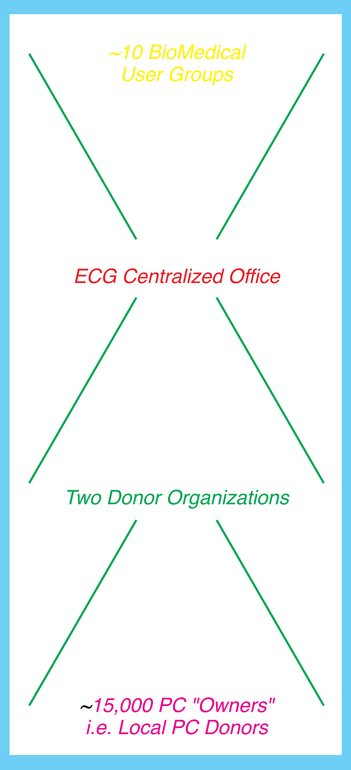

Fig. 2: The aim of the ECG is to serve the areas of research, education, and diagnostics according to the mission of the donating public organizations. Beyond, the aim is to develop the ECG to the point that it is a general broker for computing resources also for industry and other

Research:
- genomic and proteomic analysis
- epidemiology
- image analysis

Education:
- training the future grid IT specialists
- new concept development

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

Industry:
- brokerage of computing resources

INVERSE TRAGEDY OF THE COMMONS

With ever-new technologies emerging from research and development, also the amount of data, which has to be stored and analysed by advanced information technologies, is growing exponentially. In no other than the IT sector it is immanently simpler to share existing but unexploited resources. However, the resulting grid phenomenon and its implications show that this is similar complicated to the ecology/climate/environmental challange!

The Tragedy of the Commons:
A resource belonging to all and being on limited demand is overexploited and/or destroyed by the user 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!

The grid challenges reside in the e-Social embedding of grid phenomenons:

Micro-Sociality:
The sharing attitude and the socialisation of the

Macro-Sociality:
The organization culture of the embedding institution.

Similarity:
Renewable Energy Resources!

CONCLUSION

Huge resources are availabe e.g. in the IT and the renewable energy sectors, but are not exploited due to the existence of an inverse tragedy of the commons. To exploit those resources both the autopoietic tragedy of social sub-subsystems and the individual risk psychology have to be integrated in a human ecology manner both on the micro and macro level. Consequently, the grid challenge in IT of virtualizing the huge and largely available hardware resources can be made achieved by e-Human "Grid" Ecology which on the operational level means the participative integration of individual applyers with the set-up of open and sustainable management structures complying to autopoietic e-Social sub-systems. Consequently, e-Human "Grid" Ecology can serve as a solution for the inverse tragedy of the commons and its challenge in many sectors as e.g. in the renewable energy sector and thus the climate problem.

MediGRID

MediGRID and its services branch Services@MediGRID operate the national German biomedical research and care grid and is one of ~20 community grids of the German nation wide D-Grid initiative. The resources are cluster computers which are located and maintained at local universities. These resources run different middlewares and are connected by a a central access portal. Special security protocols allow data transfer between the clusters at different organizations under high-security medical conditions. The German MediGRID is one of the most advanced HealthGrids in the world combining data storage, computing power and sharing of

Fig. 3: The main organization structure of MediGRID is determined by user groups, which access via a central portal (organized by a decentral office) the distributed resources donated by different local organizations, which run cluster computers at their local institutions

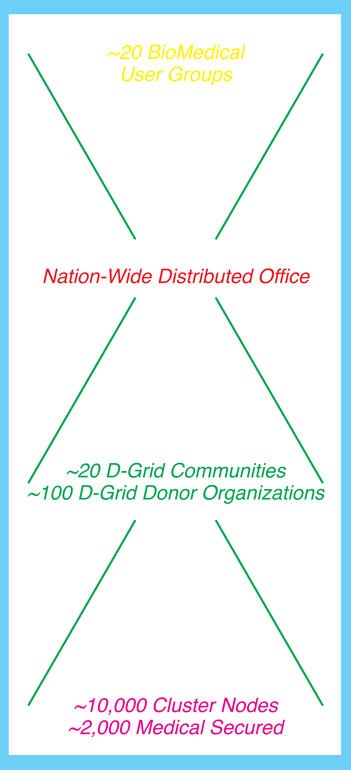

Fig. 4: To serve research, education, and diagnostics in the biomedical research and care sectors MediGRID is organized in different modules which are distributed via different institutions throughout Germany. Services are provided to MediGRID by its special services branch

Module Coordination:
- coordination of distributed office

Module Resource Integration:
- sharing of the integrated resources

Module Middleware:
- grid technical virtualization

Module Ontology Tools:
- ontology development for grid

Module Biomedical Informatics:
- user projects in clinical imaging

Module Clinical Imaging
- user projects in clinical imaging

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

Services@MediGRID:

AUTOPOIETIC SOCIAL SYSTEMS

The challenge of integrating resources in a virtualized manner involves naturally all stakeholders of society as e.g. the ECG and MediGRID organization (Fig. 1 - 4). The existence of an inverse tragedy of the commons in the grid sector and its macro and micro social aspects point to the major importance of the complexity of the interaction of the social sub-systems. I.e. that the social systems theory by Niklas Luhmann (1927-1998) - based on the autopoietic concept of Humberto Maturana and Francisco Varela (1946-2001) - can be used as the most advanced social systems theory to describe the huge complexity of the macro sociality of the grid phenomenon. Consequently, many of the conundrums appearing during the internalization of grids into society become evident and are in agreement

The Social Sub-Systems Systems:
- Religion
- Education
- Science **=> Currently grid involves only considerably science =>**
- Art
- Economy
- Jurisdiction
- Policy

:The Autopoietic 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 integra-tion of autopoietic sub-systems towards a working grid society:

Micro-Sub-Systems:
The sub-system stickyness of individuals.

Macro-Sub-Systems:
The integration of institutionalized

e-HUMAN "GRID" ECOLOGY

To overcome the "dare-to-share" attitude in respect to the inverse tragedy of the commons in the grid sector, a sustainable grid ecology within the e-Society is crucial for the success of the grid sector. I.e. that the e-Human Ecology of grid balances the integration of individual grid psychology with autopoietic e-Social sub-systems. Thus, the Human Ecology paradigm developed by Robert Park (1864-1944) and Ernest Burgess (1886-1966) evolving in Chicago in the 1920's concerning city development applies. Consequently, e-Human "Grid" Ecology provides a solution to the inverse tragedy of the commons as e.g. also

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

The solution of the inverse tragedy of the

Micro-Operationality:
The participative integration of fundamental IT applications of major individual users complying with

Macro-Operationality:
The set-up of an open and sustainable management structure complying to all the autopoietic e-Social

GRID PSYCHOLOGY

Each implementation and internalization of a new technology is based on a positive relation between the risk and the profit involved. Every society is constituted by its individuals, thus the challenge of integrating resources in a virtualized manner involves as a matter of fact the individual human beings of the different institutionalized stakeholders of society. These individuals shape the individual actions of e.g. the ECG and MediGRID organization according to their function in a social sub-system. How an individual is perceiving the risk/profit ratio depends on its personal individual risk psychology matrix. The personal position and the code of the social sub-systems constitute a complex conflict field whose state determines the success of the actions of both the

The Individual Risk Psychology Matrix:
- Individual Security Perception and Risk Acceptance
- Knowledge Based Security and Risk Perception
- Incidental Security Reaction Behaviour
- Legal and Political Security Scenarios
- Religious and Cultural Security Archetypi

:The Autopoietic Link
Genetics & Deep Psychology -
Education & Science -
Economics & Realities -
Jurisdiction & Politics -
Religion, Art, & Culture -

The risk challenge lies in a unified concept addressing the psychology of grid and its link to the social subsystems:

Micro-Risk-Managment:
The risk in the individual perception and the

Macro-Risk-Managment:
The risks in the procedural and institutionalization of

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e-Human "Grid" Ecology

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Abstract

With ever-new technologies emerging also the amount of information to be stored and processed is growing exponentially and is believed to be always at the limit. In contrast, however, huge resources are available in the IT sector alike e.g. the renewable energy sector, which are often even not at all used. This under-usage bares any rational especially in the IT sector where e.g. virtualisation and grid approaches could be fast implemented due to the great technical and fast turnover opportunities. Here, we describe this obvious paradox for the first time as the *Inverse Tragedy of the Commons*, in contrast to the *Classical Tragedy of the Commons* where resources are overexploited. From this perspective the grid IT sector attempting to share resources for better efficiency, reveals two challenges leading to the heart of the paradox: i) From a macro perspective all grid infrastructures involve not only mere technical solutions but also dominantly all of the autopoietic social sub-systems ranging from religion to policy. ii) On the micro level the individual players and their psychology and risk behaviour are of major importance for acting within the macro autopoietic framework. Thus, the challenges of grid implementation are similar to those of e.g. climate protection. This is well described by the classic *Human Ecology* triangle and our extension to a rectangle: environment-individual-society-environment. Extension of this classical interdisciplinary field of basic and applied research to an *e-Human Grid Ecology* rational, allows the *Inverse Tragedy of the Commons* of the grid sector to be understood and approached better and implies obvious guidelines in the day-to-day management for grid and other (networked) resources, which is of importance for many fields with similar paradoxes as in (e-)society.

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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.

Literature References

Knoch, T. A. Dreidimensionale Organisation von Chromosomen-Domänen in Simulation und Experiment. (Three-dimensional organization of chromosome domains in simulation and experiment.) *Diploma Thesis*, Faculty for Physics and Astronomy, Ruperto-Carola University, Heidelberg, Germany, 1998, and TAK Press, Tobias A. Knoch, Mannheim, Germany, ISBN 3-00-010685-5 and ISBN 978-3-00-010685-9 (soft cover, 2rd ed.), ISBN 3-00-035857-9 and ISBN 978-3-00-0358857-0 (hard cover, 2rd ed.), ISBN 3-00-035858-7, and ISBN 978-3-00-035858-6 (DVD, 2rd ed.), 1998.

Knoch, T. A., Münkel, C. & Langowski, J. Three-dimensional organization of chromosome territories and the human cell nucleus - about the structure of a self replicating nano fabrication site. *Foresight Institute - Article Archive*, Foresight Institute, Palo Alto, *CA, USA,* http://www. foresight.org, 1- 6, 1998.

Knoch, T. A., Münkel, C. & Langowski, J. Three-Dimensional Organization of Chromosome Territories and the Human Interphase Nucleus. *High Performance Scientific Supercomputing*, editor Wilfried Juling, Scientific Supercomputing Center (SSC) Karlsruhe, University of Karlsruhe (TH), 27- 29, 1999.

Knoch, T. A., Münkel, C. & Langowski, J. Three-dimensional organization of chromosome territories in the human interphase nucleus. *High Performance Computing in Science and Engineering 1999*, editors Krause, E. & Jäger, W., High-Performance Computing Center (HLRS) Stuttgart, University of Stuttgart, Springer Berlin-Heidelberg-New York, ISBN 3-540-66504-8, 229-238, 2000.

Bestvater, F., **Knoch, T. A.**, Langowski, J. & Spiess, E. GFP-Walking: Artificial construct conversions caused by simultaneous cotransfection. *BioTechniques* 32(4), 844-854, 2002.

Knoch, T. A. (editor), Backes, M., Baumgärtner, V., Eysel, G., Fehrenbach, H., Göker, M., Hampl, J., Hampl, U., Hartmann, D., Hitzelberger, H., Nambena, J., Rehberg, U., Schmidt, S., Weber, A., & Weidemann, T. Humanökologische Perspectiven Wechsel - Festschrift zu Ehren des 70. Geburtstags von Prof. Dr. Kurt Egger. Human Ecology Working Group, Ruperto-Carola University of Heidelberg, Heidelberg, Germany, 2002.

Knoch, T. A. Approaching the three-dimensional organization of the human genome: structural-, scaling- and dynamic properties in the simulation of interphase chromosomes and cell nuclei, long- range correlations in complete genomes, *in vivo* quantification of the chromatin distribution, construct conversions in simultaneous co-transfections. *Dissertation*, Ruperto-Carola University, Heidelberg, Germany, and TAK†Press, Tobias A. Knoch, Mannheim, Germany, ISBN 3-00-009959-X and ISBN 978-3-00-009959-5 (soft cover, 3rd ed.), ISBN 3-00-009960-3 and ISBN 978-3-00-009960-1 (hard cover, 3rd ed.), ISBN 3-00-035856-9 and ISBN 978-3-00-010685-9 (DVD, 3rd ed.) 2002.

Knoch, T. A. Towards a holistic understanding of the human genome by determination and integration of its sequential and three-dimensional organization. *High Performance Computing in Science and Engineering 2003*, editors Krause, E., Jäger, W. & Resch, M., High-Performance Computing Center (HLRS) Stuttgart, University of Stuttgart, Springer Berlin-Heidelberg-New York, ISBN 3- 540-40850-9, 421-440, 2003.

Wachsmuth, M., Weidemann, T., Müller, G., Urs W. Hoffmann-Rohrer, **Knoch, T. A.**, Waldeck, W. & Langowski, J. Analyzing intracellular binding and diffusion with continuous fluorescence photobleaching. *Biophys. J.* 84(5), 3353-3363, 2003.

Weidemann, T., Wachsmuth, M., **Knoch, T. A.**, Müller, G., Waldeck, W. & Langowski, J. Counting nucleosomes in living cells with a combination of fluorescence correlation spectroscopy and confocal imaging. *J. Mol. Biol.* 334(2), 229-240, 2003.

Fejes Tóth, K., **Knoch**, **T. A.**, Wachsmuth, M., Frank-Stöhr, M., Stöhr, M., Bacher, C. P., Müller, G. & Rippe, K. Trichostatin A induced histone acetylation causes decondensation of interphase chromatin. *J. Cell Science* 177, 4277-4287, 2004.

Ermler, S., Krunic, D., **Knoch, T. A.**, Moshir, S., Mai, S., Greulich-Bode, K. M. & Boukamp, P. Cell cycle-dependent 3D distribution of telomeres and telomere repeat-binding factor 2 (TRF2) in HaCaT and HaCaT-myc cells. *Europ. J. Cell Biol.* 83(11-12), 681-690, 2004.

Kost, C., Gama de Oliveira, E., **Knoch, T. A.** & Wirth, R. Spatio-temporal permanence and plasticity of foraging trails in young and mature leaf-cutting ant colonies (*Atta spp.*). *J. Trop. Ecol.* 21(6), 677- 688, 2005.

Winnefeld, M., Grewenig, A., Schnölzer, M., Spring, H., **Knoch, T. A.**, Gan, E. C., Rommelaere, J. & Cziepluch, C. Human SGT interacts with BAG-6/Bat-3/Scythe and cells with reduced levels of either

protein display persistence of few misaligned chromosomes and mitotic arrest. *Exp. Cell Res.* 312, 2500-2514, 2006.

Sax, U., Weisbecker, A., Falkner, J., Viezens, F., Yassene, M., Hartung, M., Bart, J., Krefting, D., **Knoch, T. A.** & Semler, S. Grid-basierte Services für die elektronische Patientenakte der Zukunft. *E- HEALTH-COM - Magazin für Gesundheitstelematik und Telemedizin*, 4(2), 61-63, 2007.

de Zeeuw, L. V., **Knoch, T. A.,** van den Berg, J. & Grosveld, F. G. Erasmus Computing Grid - Het bouwen van een 20 TeraFLOP virtuelle supercomputer. *NIOC proceedings 2007 - het perspective of lange termijn*. editor Frederik, H. NIOC, Amsterdam, The Netherlands, 52-59, 2007.

Rauch, J., **Knoch, T. A.** , Solovei, I., Teller, K. Stein, S., Buiting, K., Horsthemke, B., Langowski, J., Cremer, T., Hausmann, M. & Cremer, C. Lightoptical precision measurements of the Prader- Willi/Angelman Syndrome imprinting locus in human cell nuclei indicate maximum condensation changes in the few hundred nanometer range. *Differentiation* 76(1), 66-82, 2008.

Sax, U., Weisbecker, A., Falkner, J., Viezens, F., Mohammed, Y., Hartung, M., Bart, J., Krefting, D., **Knoch, T. A.** & Semler, S. C. Auf dem Weg zur individualisierten Medizin - Grid-basierte Services für die EPA der Zukunft. *Telemedizinführer Deutschland 2008*, editor Jäckel, A. Deutsches Medizinforum, Minerva KG, Darmstadt, ISBN 3-937948-06-6, ISBN-13 9783937948065, 47-51, 2008.

Drägestein, K. A., van Capellen, W. A., van Haren, J. Tsibidis, G. D., Akhmanova, A., **Knoch, T. A.**, Grosveld, F. G. & Galjart, N. Dynamic behavior of GFP-CLIP-170 reveals fast protein turnover on microtubule plus ends. *J. Cell Biol. 180(4)*, 729-737, 2008.

Jhunjhunwala, S., van Zelm, M. C., Peak, M. M., Cutchin, S., Riblet, R., van Dongen, J. J. M., Grosveld, F. G., **Knoch, T. A.**$^{+}$ & Murre, C.$^{+}$ The 3D-structure of the Immunoglobulin Heavy Chain Locus: implications for long-range genomic interactions. *Cell 133(2)*, 265-279, 2008.

Krefting, D., Bart, J., Beronov, K., Dzhimova, O., Falkner, J., Hartung, M., Hoheisel, A., **Knoch, T. A.**, Lingner, T., Mohammed, Y., Peter, K., Rahm, E., Sax, U., Sommerfeld, D., Steinke, T., Tolxdorff, T., Vossberg, M., Viezens, F. & Weisbecker, A. MediGRID - Towards a user friendly secured grid infrastructure. *Future Generation Computer Systems 25(3)*, 326-336, 2008.

Knoch, T. A., Lesnussa, M., Kepper, F. N., Eussen, H. B., & Grosveld, F. G. The GLOBE 3D Genome Platform - Towards a novel system-biological paper tool to integrate the huge complexity of genome organization and function. *Stud. Health. Technol. Inform. 147*, 105-116, 2009.

Knoch, T. A., Baumgärtner, V., de Zeeuw, L. V., Grosveld, F. G., & Egger, K. e-Human Grid Ecology: Understanding and approaching the Inverse Tragedy of the Commons in the e-Grid Society. *Stud. Health. Technol. Inform. 147*, 269-276, 2009.

Dickmann, F., Kaspar, M., Löhnardt, B., **Knoch, T. A.,** & Sax, U. Perspectives of MediGRID. *Stud. Health. Technol. Inform. 147*, 173-182, 2009.

Knoch, T. A., Göcker, M., Lohner, R., Abuseiris, A. & Grosveld, F. G. Fine-structured multi-scaling long-range correlations in completely sequenced genomes - features, origin and classification. *Eur. Biophys. J. 38(6)*, 757-779, 2009.

Dickmann, F., Kaspar, M., Löhnhardt, B., Kepper, N., Viezens, F., Hertel, F., Lesnussa, M., Mohammed, Y., Thiel, A., Steinke, T., Bernarding, J., Krefting, D., **Knoch, T. A.** & Sax, U. Visualization in health-grid environments: a novel service and business approach. *LNCS 5745*, 150-159, 2009.

Dickmann, F., Kaspar, M., Löhnhardt, B., Kepper, N., Viezens, F., Hertel, F., Lesnussa, M., Mohammed, Y., Thiel, A., Steinke, T., Bernarding, J., Krefting, D., **Knoch, T. A.** & Sax, U. Visualization in health-grid environments: a novel service and business approach. *Grid economics and business models - GECON 2009 Proceedings, 6th international workshop, Delft, The Netherlands.* editors Altmann, J., Buyya, R. & Rana, O. F., GECON 2009, LNCS 5745, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-03863-1, 150-159, 2009.

Estrada, K.*, Abuseiris, A.*, Grosveld, F. G., Uitterlinden, A. G., **Knoch, T. A.**$^{+}$ & Rivadeneira, F.$^{+}$ GRIMP: A web- and grid-based tool for high-speed analysis of large-scale genome-wide association using imputed data. *Bioinformatics 25(20), 2750-2752*, 2009.

Kepper, N., Schmitt, E., Lesnussa, M., Weiland, Y., Eussen, H. B., Grosveld, F. G., Hausmann, M. & **Knoch T. A.,** Visualization, Analysis, and Design of COMBO-FISH Probes in the Grid-Based GLOBE 3D Genome Platform. *Stud. Health Technol. Inform. 159*, 171-180, 2010.

Kepper, N., Ettig, R., Dickmann, F., Stehr, R., Grosveld, F. G., Wedemann, G. & **Knoch, T. A.** Parallel high-performance grid computing: capabilities and opportunities of a novel demanding service and business class allowing highest resource efficiency. *Stud. Health Technol. Inform. 159*, 264-271, 2010.

Skrowny, D., Dickmann, F., Löhnhardt, B., **Knoch, T. A.** & Sax, U. Development of an information platform for new grid users in the biomedical field. *Stud. Health Technol. Inform. 159*, 277-282, 2010.

Knoch, T. A., Baumgärtner, V., Grosveld, F. G. & Egger, K. Approaching the internalization challenge of grid technologies into e-Society by e-Human "Grid" Ecology. *Economics of Grids, Clouds, Systems, and Services – GECON 2010 Proceedings*, 7th International Workshop, Ischia, Italy, editors Altman, J., & Rana, O. F., Lecture Notes in Computer Science (LNCS) 6296, Springer Berlin Heidelberg New York, ISSN 0302-9743, ISBN-10 3-642-15680-0, ISBN-13 978-3-642-15680-9, 116-128, 2010.

Dickmann, F., Brodhun, M., Falkner, J., **Knoch, T. A.** & Sax, U. Technology transfer of dynamic IT outsourcing requires security measures in SLAs. *Economics of Grids, Clouds, Systems, and Services – GECON 2010 Proceedings*, 7th International Workshop, Ischia, Italy, editors Altman, J., & Rana, O. F., Lecture Notes in Computer Science (LNCS) 6296, Springer Berlin Heidelberg New York, ISSN 0302-9743, ISBN-10 3-642-15680-0, ISBN-13 978-3-642-15680-9, 1-115, 2010.