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Nature-inspired Smart Information Systems

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1 Introduction

This Final Report is a summary about the NiSIS activities from 1st of February, 2005 to 31st of January, 2008. NiSIS was founded as a Coordination Action at the beginning of 2005 for a duration of 36 months. It is funded by the Information Society Technologies Programme (IST) within the European Union 6th Framework Programme. NiSIS mainly concerns with aspects of nature and biology that can be sources of inspiration for ICT systems.

2 Publishable final activity report

The overall mission of NiSIS was to coordinate multi-disciplinary studies and research endeavours into the development and utilisation of intelligent paradigms in advanced information systems. The project has bee actively supported by members from more than 60 research institutes at industries and universities all across Europe.

The Focus Groups dealed with theoretical and technological aspects and new developments covering the theme of nature-inspired systems in the areas of:

- Nature-inspired Data Technology (NiDT)
- Nature-inspired Networks (NiN)
- Nature-inspired Systems Modelling, Optimisation and Control (NiMOC)

The overall integration of the Project results has been overseen by an **ITB** (Integrated Technology Board). It deals also with relationships to other EU-projects and national projects, including linkage with existing Networks and development of the NiSIS Roadmap.

During the three years of the project lift time, the Integration Technology Board has met 11 times. Two big Meetings with all contractors took place at Majorca in June 2006 and in Aachen in September 2007, while the emphasis of these events was to bring together all the members of NiSIS to engage in brainstorming, also with regard to the NiSIS Roadmap input. The last ITB meeting during the Annual Symposium held in Malta from 26-28 November 2007 concentrated on the details of the publication of the Roadmap and preparation for the 3rd Periodic Progress Report and Management Report. It was decided to use the ELITE Foundation facilities for the Roadmap publication because of their expertise in preparation of widely distributed literature for newsletters etc.

Three Annual Symposia have been organised by the European NiSIS Co-ordination Group which have shown state-of-the-art presentations as well as new developments in Nature-inspired Systems with Intelligent Technologies. These events were usually structured into Plenaries with very interesting and diverse talks by renowned speakers as well as different parallel Sessions where experts lectured their developments and applications in various areas. In between, very lively discussions took place between the participants from different countries. It was always encouraging to see that also students and young researchers participated, as it is was of the objectives of NiSIS to involve new and young people.

The NiSIS Competitions were an ideal instruments which have motivated scientists to develop new ideas. Traditionally, the competitions in NiSIS were organised by the committee which is responsible for Technology Transfer within the network and the winners were awarded during the Annual Symposia.

All the initiated 12 Task Forces have completed their period of budgeting and work plan. ITB members have been involved personally in these Task Forces and their performance has been monitored and reported on in the list of activities below. Generally, they have fulfilled their aims well and indeed have led to several initiatives in FP7 STREPS proposals in the Open FET programme. There has been significant cross-over between personnel in the Focus Groups and the Task force programmes of work.

The 3 Focus Groups and the TTE committee have reported in detail about their activities in the 3 different Periodic Progress Reports.

The membership has remained constant during 2007 at 64, there being deliberately no particular attempt to promote an increase for the final year of the project. Consolidation has been the major aim and the ITB analysis of the Final Annual Symposium suggested a very positive outcome from this final event. The EU projects Neuro-IT and ONCE-CS were invited to be involved in the NiSIS Annual Symposium held in Malta during November 2007.

The Management and Service Centre in Aachen, Germany was the central information source and responsible for the administration of the project. The regular attendance of a permanent employee guaranteed prompt processing of project affairs. This included basically to deal with general inquiries, organisation of events and workshops, circulation of information, project promotion, financial administration, providing relevant contacts and the continuous update of the NiSIS web site content.

In the main, NiSIS has achieved the targeted expectations and the work always proceeded in a very positive atmosphere, favoured by the manageable number of participants who know each other quite well.

3 Using and disseminating the knowledge

The NiSIS web site turned out to be the main working environment to publish material, to exchange information and to call the attention of the members and other interested people to new uploads to certain activities. The news section could very efficiently be used to announce up-to-date business and in the event section everybody could place interesting NiSIS related calls and event notes. A platform for collaborative authoring has been created, like the NiSIS Glossary.

3.1 Roadmap – Grand Challenges

In the last year of the project life time, various contributions for the Roadmap Grand Challenges have been made. At the Aachen meeting organized for all members on 6./7. September 2007 refining of Chapter 4 was undertaken together with the gathering of material for Chapter 5 on Impact. The conceptual Grand Challenge for building smart information systems is the mimicking of many of the desirable qualities, features and capabilities of the natural systems showing intelligent behaviour, both in their distinct functionalities and in their aggregated actions.

We can identify the collection of these characteristics under the common umbrella of **Bio-mimetic Intelligence** (BmI) or, in other words, the ability of an information system to *mimic* nature-inspired adaptive and intelligent behaviour to better pursue its goals, to improve the robustness, efficiency and usefulness of its functionalities and enhance its interfacing capabilities to the external world.

The word Bio-Mimetic expands and, at the same time, specifies the target research field. While terms like "Artificial Intelligence", or the more recent "Computational Intelligence", have been identifying a precise notion of intelligent behaviour by mimicking human intelligence through symbolic or sub-symbolic computation , BMI tries to grasp the core of intelligent behaviour from a broader perspective, through technologies inspired by natural systems behaviour. In fact, the idea of BmI is to extend the inspiration from the micro to the macro-level of natural intelligent behaviour, that is from organic or inorganic molecules (e.g. DNA computing, evolutionary computation, etc.), through unicellular organisms and tissues (e.g. membrane computing, quorum sensing, amorphous computing, neural computation, etc.), up to complex organisms and their aggregations (e.g. swarm intelligence, ants colony, intelligent agents, social networks, etc.).

It should be noted that, even if some of the biological details giving rise to intelligent behaviour are unknown and will be obscure even in the near future, nevertheless information systems can benefit from macro-level BmI as a source of inspiration. Already successful cases along this line are,

for example, the evolutionary computation and swarm intelligence research fields, that have shown exceptional advances in recent years for information systems despite the corresponding biological mechanisms are not clearly understood.
Thus, the development of new and advanced Smart Information Systems relies both in the understanding and mainly on the imitation of intelligent behaviour. Several of the Grand Challenges for Information Systems are still the same as many decades ago, despite the vast amount of technological advances, but having Bio-mimetic Intelligence as the background scenario makes it possible to see those challenges under a new light and stimulate new research methodologies.

Computational Nervous System
The *rationale* behind the design of a Computational Nervous System (CNS) is the development of "*sensing capabilities*" in information systems. These capabilities, when addressing an information system, are related both to the acquisition of information from the external world and the understanding of its internal functioning and performance.

Brain-like Computing

The *rationale* behind the design of Brain-like Computing (BIC) is the development of an information system with brain-like computational capabilities. Two main methodologies appear to be promising: the first one tries to understand and then map brain functionalities on conventional computer systems , the second one builds on next-generation computational devices for building computing systems having a complexity comparable to biological systems.
The *ultimate goal* is to provide an information system able to take real-time decisions, extract, maintain, manage and memorize valuable spatial-temporal information and knowledge in efficient ways, perform associations between problems and solutions and, eventually, build new solutions to unknown problems (e.g. through creativity processes).

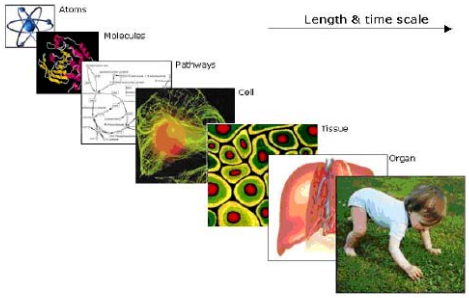
Distributed Cooperative Intelligence

The rationale behind the design of Distributed Cooperative Intelligence (DCI) is the necessity of dealing with the increasing complexity of information systems through non-centralized mechanisms, as in biological systems.

Networks

Advances in micro-electronics have led to a vast increase in the processing power and/or sensing abilities of many everyday objects. At the same time, advances in communication technologies (both wireless and wired) mean that it is possible to transfer data much more quickly and efficiently than before. Taken together, these advances are leading to complex networks involving increasing scale and heterogeneity. Examples include next-generation telecommunications networks and pervasive computing systems.

As a historical parallel, the early days of telephone networks required manual switching of calls by operators. Without automation, either telephone calls would be a rarity or the number of telephone operators would be several orders of magnitude larger. The equivalent problem today is the number of highly skilled technical personnel to configure and maintain complex networks. The challenge (identified by IBM, amongst others, in its autonomic computing initiative) is to automate these processes by emulating the way the body regulates and controls itself. This entails subsidiary goals of self-configuration, self-monitoring, self-optimisation, self-maintenance and self-protection.
Modern economies thrive on increased trade amongst different regions, countries and continents. Logistic and transport networks thus become larger and more complex. People are also more mobile, and sustainable mobility is nowadays an issue for many countries. Effective control of such networks saves much valuable resources for the economy, decreasing idle times, increasing (road) utilization and preventing unnecessary delay. Such networks should ideally be self-managing, much as communication networks. An additional challenge is that humans are usually in the loop in transport networks (e.g. which route to take) and hence optimal decisions cannot be imposed, but only recommended. It becomes then important to design advanced interaction mechanisms for interaction with humans to improve mobility and the operations of the transport network.



Modelling

Multi-scale modelling and simulation approach involves across-scale modelling in time and space. It integrates data-based and knowledge-based modules. The architecture of a prototype multi-modular model system must be designed and applied. Applying this architecture the aggregate behaviour must be studied, compared with the real observed behaviour and used to improve the architecture of the multi-modular model. Modules must be tested and simulated individually and after merging in common simulation results must be documented in terms of SBML. There must be provided several variants of constituent model models and user-defined composition of the entire model must be allowed . User-defined composition must be guided by SBML code in the background .It becomes then important to design advanced interaction mechanisms for interaction with humans to improve mobility and the operations of the transport network.

Optimization and Control

Bio-mimetic solutions in evolutionary algorithms that mimic not only micro-evolution but also macro-evolutionary strategies (learning from the "big steps" in biological evolution) are grand challenges in nature-inspired optimization and control. Micro-evolution is defined as the change of allele frequencies (that is, genetic variation due to processes such as selection, mutation, genetic drift, or even migration) within a population. Macroevolution is defined as evolutionary change at the species level or higher, that is, the formation of new species, new genera, and so forth. Evolutionary novelties at macro-evolutionary level appear through manifestation of genetic mutations at micro-evolutionary level, in a new metabolic network, leading to different phenotype in both protein equipment and behaviour. The biomimetic translation means emergent changes in simulation behaviour (phenotype) by minor changes of the model (genotype).
In computing, multitasking is a method by which multiple tasks, also known as processes, share common processing resources such as a CPU. Its optimization concerns CPU usage by the scheduling strategy. It is not known if biological multitasking in the liver can be a model for multitasking in computing although presumably in biology, too, multitasking operates through resource sharing or by division of labour among different cell types. Optimization by permanently

renewed (recycled) material can be learned e.g. from the regeneration of liver cells/hepatocytes, based on modelling of spatio-temporal organization.
Self-configurability with respect to network services is the capability of a system to configure its own network-based services and applications in response to the needs of the user and the environment the system finds itself in. As the needs of the user change or the environment the system is in changes, the end-user system would recognize the change, understand the impact, and respond by reconfiguring itself accordingly. Flexibility of location, a wide range of administrative control, and the need for varied rates of dispersal of changed configuration information across the environment, all complicate the task of autonomic network services configuration behaviour.

Control of interconnected processes can be learned e.g. from coordinated action of E. coli catabolism and anabolism. Anabolism is the building up of complex molecules, while catabolism is their breakdown. To build molecules and sustain life, the body needs energy. So, for molecular construction to occur, molecular destruction must go on at the same time to release the energy required to drive the biochemical reactions. There are many interconnected processes in tumorigenesis, involving tumor cell signaling and information processing.

3.2 NiSIS Competition

Why did we organize Competitions ?

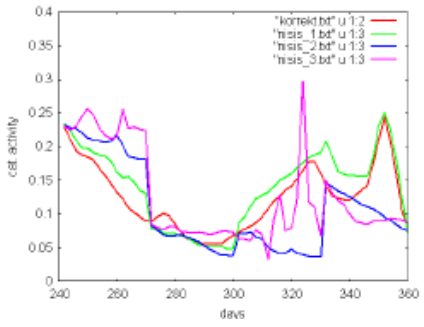
Scientific competitions are well-known instruments which have motivated scientists to develop new ideas for several centuries. Today too, large sums of money are sometimes offered as prizes for solutions to unsolved problems in various fields of natural science. The Clay Mathematics Institute has singled out seven so-called Millennium Problems, for which prizes totalling seven million dollars have been offered. Without offering monetary prizes we have made very good experiences with a series of competitions in the framework of former EU networks (NoE's EUNITE, ERUDIT) and consequently the TTE committee will organize new competitions in NISIS. The continuing receipt of enquiries and requests for data and solutions from the 1998 to 2000 competitions even today is highly encouraging. If scientists employ the competition data as a benchmark, this is a reliable indication that we have made a correct selection of problems.

What are the reasons for the motivation to participate in such a competition? Without any doubt a successful score in a competition can positively accentuate one's personal curriculum vitae. This feature is especially important for participants from universities. On the other hand, it may also prove to be beneficial for one's own career. Above all, however, it thus became evident that the company's own R&D personnel perform at a high level, and that they need not be afraid of comparisons with specialists elsewhere. This aspect is of particular interest, since very few opportunities for benchmarking otherwise exist for such positions in a company. A competition offers a possibility of appraising the status of one's own algorithms, that is, how good one's own approach is in comparison with those of other specialists.

Competition 2006

Problem task 'Soft Sensor for the adaptive Catalyst Monitoring of a Multi-Tube Reactor'.

Description of the problem:
The reactor to be modelled consists of some 1000 tubes filled with catalyst, used to oxidize a gaseous feed (ethane is taken as example). It is cooled with a coolant supposed to be at constant temperature. The description of the reaction speed is taken from literature and depends strongly non-linearly from temperature.
Its exothermal reaction is counteracted by the cooling and leads to a temperature maximum somewhere along the length of the tube. As the catalyst decays, this becomes less pronounced and moves further downstream. The catalyst activity usually decays within some time to zero, a year is taken as example here. The process to be modelled takes input from other, larger processes, so that the feed will vary over the days. The operating personal reacts to this by choosing appropriate operating conditions. The catalyst decay is however much slower than these effects.



Winner of the 2006 competition:
Dymitr Ruta
British Telecommunication plc
United Kingdom

Award "Best nature inspired concept":
Martin Macaš
Czech Technical University
in Prague

Competition 2007

Problem Task: Analysis and Classification of the DaimlerChrysler Automotive Dataset Images

Description of the problem:

The DaimlerChrysler dataset ws targeted to an automotive application [1]: the problem consists in the detection of pedestrians against a background or other objects. It was possible to download up to 5 different datasets, each one made up by 9800 images (4900 pedestrian and 4900 non-pedestrian examples).
The scope of the analysis of this dataset was to find a model which can classify the images obtained from the camera. In the eyes of DaimlerChrysler purposes, the model is going to be used as driving support for high-grade cars: in the same breath, this dataset is standing out as a benchmarking one mainly for testing intelligent embedded systems, widely used in automotive applications.

Winner of the competition with the approach:
Scheme of Primate's Visual Cortex Cells for Pedestrian Recognition
Luciano Oliveira, Urbano Nunes and Paulo Peixoto
Institute of Systems and Robotics, University of Coimbra, Portugal

Winner of the competition with the approach :
Mixture of Gaussians Model for Robust Pedestrian Images Detection
Dymitr Ruta, United Kingdom

Special award with the approach:
Image Pattern Recognition by Ensemble of Classifiers
Cs. Gáspár-Papanek, Zs.T. Kardkovács, G. Szabó, E. Sipocz, G. Pécsi and M.A. Szoke
Department of Telecommunication and Media Informatics, Budapest University of Technology and Economics, Hungary

3.3 Task Forces

The idea:

The initiation of „Task Forces" is an effective and flexible tool enabling the project to deal with research issues that arise during the lifetime of the project. In NiSIS, the procedure for applying, accepting and managing Task Forces follows a given structure. All NiSIS members have been strongly encouraged to participate actively in initiating Task Forces.

The fostering of scientific development within the theme of nature-inspired systems area is organised by the Task Forces. They support NiSIS and also other initiatives and projects with new research ideas and will also advance the forming of interdisciplinary partnerships and consortia. The operation is mainly in organising workshops and other events concentrating on the development of nature-inspired systems. This, combined with the work done in the Focus Groups, may also pave the way to the development of 'Nature-inspired Systems Science Theory'. Task Forces will also provide materials and ideas for the Roadmap.

Task Forces in 2006:

The 6 Task Forces commissioned in 01.10.2005 for one year have been:

- NISSPI (Nature Inspired Self- healing soft Sensors for Industry) achieved strong co-operation between industry and academia and was very active in workshops and meetings between the participants. There was significant interaction with biologists in attempts to bridge the knowledge gap between engineers and life scientists. The chemical industrial company Degussa were very involved in the NiSIS Competition, both providing data for analysis and interaction in the results.

- "The origin of adaptability in natural networks" had a strong biological drive, but with active connection with computer science. An excellent Symposium on "Network Analysis in Natural Sciences and Engineering" was organised within the conference "Adaptation in Artificial and Biological Systems" held at Bristol UK in April 2006. There was good interaction between biologists and engineers with lively debate. The whole conference was of special relevance to one of the major themes of NiSIS.

- NICSO (Nature Inspired Cooperative Strategies for Optimisation) undertook extensive literature and simulation studies in the area of optimisation, which has huge potential in information systems. The group considered many possible strategies which have significant potential in the future.

- "Nature Inspired Monitoring and Control" had major inputs from biotechnology and biology. Following a working meeting in Vienna at which the main thrust of the Task Force was established, a survey was commissioned on "Information Flow in Biosytems". The model organism chosen for this survey was e coli, since that is one of the best understood mechanisms from which we may obtain inspiration for information systems of the future. Based on e coli, a Case Study was performed using systems analysis and modelling, and this has been submitted for journal publication under the title "Analysis of transcriptome and proteome time series data from recombinant e coli cultivations".

- "Potential Nature-inspired Aspects in Information Networks" was coupled with the adaptability Task Force in the AISB Symposium mentioned above. The enthusiasm generated by this event has led to a Special Issue of the AI Communications (AICOM) journal being commissioned. This is providing a more thorough discussion of the state-of-the-art and trends in network analysis, all of which is useful for the NiSIS Roadmap. An initial study into subgroup dynamics in social networks was performed by a recruited member of NiSIS and has led to a possible new Task Force in the next phase of NiSIS. Arising from other discussions, an further Task Force has been initiated on "Sparking new ideas through brain-like association networks" based on the needs

and practices of large corporations, particularly in the pharmaceutical industry where drug discovery is such an important issue.

- NICOLE (Nature Inspired Combinatorial Machine Learning) organised 3 productive Workshops and considered 4 strands of machine learning. These were Discrete intelligence, Discrete internal representation of the environment, Hierarchical intelligence, and Nature-inspired methods in mining industrial data. Learning machines based on discrete calculus suffer from complexity explosion, a phenomenon well known in physics, mathematics and engineering. Nature, however, is able to approach and effectively solve very difficult problems, from which we may learn new techniques.

Task Forces in 2007:

In addition to the 6 Task forces executed in 2006, a further 6 Task forces were commissioned from 01.10.2006 and have completed their work and reported on their progress and achievements:

- The Task force on "Nature-inspired Robustness" considered 2 aspects of robustness, being that of "fault-tolerance" and "stability". Surveys of biological mechanisms suggested that there are major differences between engineered robustness and natural systems approaches Thus, higher biological organisms utilise redundancy and structural flexibility for compensation of regulatory deficiencies. However, the immune systems does provide interesting analogies and this formed the basis for the major studies undertaken. An outcome of the Task Force is the establishment of a research initiative from Feb 2008 between Goethe University, Frankfurt and Hans-Knoll-Institute, Jena into robustness concepts in modelling biochemical pathways (genes, protein and metabolic).A STREPS initiative under FP7 is planned into model-based IT Healthcare delivery for septic shock treatment.

- The Task Force on "Multitasking of Liver Tissue" was very interdisciplinary and unusual in that it included the incorporation of new experimental gene array results (funded separately from NiSIS) into the modelling studies which resulted from the initiative. Early on it became evident that words were being used differently between biologists and engineers e.g. multi-tasking!. Thus, significant time has been expended in clarifying the definition of key words in the field relevant to NiSIS and a resulting short glossary of terms has been produced. The results for gene expression in liver tissue and immunohistochemical (IHC) evidence of resultant protein expression have been incorporated into innovative compartmental modelling to describe the multitasking capabilities of one metabolic pathway. Analogies have been drawn between such metabolism and modern IT requirements such as spam filters. The work has been published and presented at several venues.

- The "Nature-inspired Methods fro Local Pattern Detection" Task force considered the problems associated with subspace clustering in high dimension data spaces. Their approach was to attempt to mimic evolutionary theory via using biological niches to represent diverse local minima in EMCO (Evolutionary Multi-objective Optimisation).The results obtained were promising but for very high dimensional spaces the problem of scalability remains, for which models of overpopulation are proposed to steer emigration of individuals to less populated niches. 8 publications and presentations have arisen from the work.

- PIALM was an unusual Task Force in that it is based on the use of physically-based analogies for IT algorithms rather than the predominantly biologically based emphasis in NiSIS. The applications were to Machine Learning and the aim was to develop hybrid particle-dynamics-based optimisation prototypes capable of handling multi-type data. Two physical mechanisms were considered in some detail, being field-based learning using interacting charged particles as the analogy and AKC(Algorithmic Kolmogorov Complexity) with its links to thermodynamic physical state and information distance. Collaborative links were made with IDSIA, Lugarno, Switzerland and Birmingham University, UK. Arising from this a STREPS FP7 Open FET proposal is being prepared containing 2 strands of Information Theoretic Learning and Physically-inspired Learning and Knowledge Discovery. The work has been presented in several meetings and an extensive journal paper is being published.

- The Task Force on "Immune System Inspired Health Monitoring of Machinery" investigated the use of AIS (Artificial Immune System) algorithms to a practical engineering problem of fault detection in roller bearing wear. They found that equivalent results could be obtained to other conventional algorithms. They concluded that one can indeed obtain inspiration from nature but should not attempt to copy it blindly. This is expected since some of the features of biological processes are domain specific and cell dependent. The Task Force provided active co-operation between Universities in Finland and Germany and across 2 NiSIS committees (TTE and NiMOC).2 papers have resulted from the studies.

- The next Task Force on "Sparking New ideas through Brian-like Association Networks" has made a successful STREPS submission under the title BISON and expects to commence in June 2008.The challenge addressed is how to utilise the massive amounts of data which are now stored in corporations of diverse nature. In particular, the pharmaceutical industry is being addressed in its drive to produce new drugs. The concept of Association Engines would augment the role of corporate memories providing meta structures which would point the user through vast information banks via exploration and context refinement.

3.4 NiSIS Annual Symposia

The NiSIS group organized 3 Annual Symposia in the years 2005, 2006 and 2007.

In these Symposia the primary concern was to show state-of-the-art presentations as well as new developments in Nature inspired Systems with Intelligent Technologies.
The focus was on the integration of life and applied sciences/engineering that address issues on smart information systems, preferably with special interest to apply this to other real-world problems. The aim also was to investigate Nature- inspired Systems that coordinate perception, reasoning, and action to pursue multiple goals while functioning autonomously in dynamic environments. NiSIS is covering Nature-inspired Data Technology (NiDT), Nature-inspired Networks (NiN), Nature-inspired Systems Modelling, Optimisation and Control (NiMOC).
NiSIS Symposia usually have parallel sessions where experts present their newest developments and applications in different areas.

NiSIS 2005 was the 1st symposium organised by the European NiSIS Co-ordination Group and took place from 4 - 5 October 2005 in Albufeira, Portugal. 53 participants could follow parallel sessions where experts presented their developments and applications in different areas. 34 papers were presented and 7 speakers were invited to have a talk in the different sessions of the symposium.

NiSIS 2006 - The 2nd European Symposium on Nature-inspired Smart Information Systems took place in Puerto de la Cruz, Tenerife, Spain from 29 November – 1 December, 2006.
NiSIS 2006 had four Plenaries with interesting, inspiring talks and twelve parallel Sessions with 46 different presentations, where experts lectured their developments and applications in different areas. In between very lively discussions took place between the 68 participants during the three days. We were glad to welcome young researcher giving presentations at the conference this year and also some new people were participating.
Furthermore, some Task Force Workshops took place, having their Kick-off ortheir final Meeting on the third day.
In the Opening Session the Project Coordinator, Karl Lieven, took the chance to inform the participants about the plans of the European Commission for the next three years. He presented the different Calls for Proposals with the main goals and explained his view about possible participation of the NiSIS group in future. Out of the Brainstorming discussions in June 2006 in Palma de Mallorca, it seems that the challenge on Cognitive Systems could be most relevant for us.

NiSIS 2007 - The 3rd European Symposium on nature-inspired Smart Information Systems took place in St. Julians, Malta from 26 – 28 November, 2007.
The event had four Plenaries with very interesting and diverse talks by renowned speakers from Sweden, Portugal, Germany and the U.S.A.

The winners of the NiSIS Team Competition presented their solutions and have been awarded on the first day. Moreover, a Special Workshop about "Assessing Risks and regulating possible applications of nature-inspired System Approaches in Industry" took place.
In different parallel Sessions experts lectured their developments and applications in various areas. In between, very lively discussions took place between the 60 participants from 19 different countries, whereas we could also welcome participants from Japan, Israel and the U.S.A. this year. It was encouraging to see that also students and young researchers participated, as it is one of the objectives of NiSIS to involve new and young people.
Another big part of the programme this year were the different Task Force Workshops. Nearly all the responsible group leaders organised a final Meeting during NiSIS 2007 and took the chance to discuss and present their results to a larger audience.

3.5 Standardization Document and Procedure for Acceptance

This document has been developed as a part of the NiSIS project, devoted to Technology Transfer, Training and Education with the main goal to support potential developers and users of nature-inspired systems as well as to facilitate the communication between the committees and partners in NiSIS. The document addresses in particular the part of the TTE related to developing the strategies to overcome the hurdless based on the high risks of nature-inspired systems which currently make their application difficult and prohibit outreach into society, in this particular case by means of pre-standardization measures.

The full document is available on the NiSIS web site www.nisis.de in the Technology Transfer area.

3.6 NiSIS Industry Workshop

NiSIS Industry Workshop "Assessing risks and regulating possible applications of nature-inspired system approaches" took place during the NiSIS 2007 Symposia at Malta.

The goal of the activity was to provide an overview of the "external" aspects for the possible NiSIS applications: i.e. if the application of the "nature-inspired smart information systems" (NiSIS) can, besides all the benefits incur risks (foreseeable or unexpected ones) and how to deal with these risks. In industry, the most common and usual way for dealing with these risks goes over standardization.
Therefore, the emphasis of the Workshop has been put onto the assessing risks and regulating possible applications of nature-inspired system approaches, primarily thought (pre-) standardization. The pre-standardization because the NiSIS technologies themselves are far from being mature or standardized themselves. The natural standardization framework for NiSIS project, as an EU project, is CEN – The European Standardization Body and the workshop has, therefore include three main groups of stakeholders:

- Industry
- Standardization bodies
- NiSIS partners

This was reflected in the program of the workshop whereas the scope-target group were the NiSIS members, consultants to the industry (Steinbeis, Fraunhofer), standardization body (CEN) and other interested persons.

NiSIS technologies confirmed the need to start preparing standardization patterns early upstream in their development and NiSIS has identified the main issues of possible standardization / pre-standardization .
The acitivities in this area will be continued also after the NiSIS project end in the follow-up project iNTeg-Risk (www.integris.eu-vri.eu) which has beeen accepted for financing in FP7.

4 Final Management Report

The Final management report consolidates the costs of all the contractors during the entire duration of the project.

4.1 All NiSiS activities at a glance:

In the table below you can see all NiSIS activities executed in the reporting period at a glance, fielded into the activity ID, the different areas, the name of the activity, the start and end date of the activity and the current status.

On the official web site of www.nisis.de you can also find all details in the member area (please ask for login details at the Service Centre)

ID	Area	Activity name	Status	Start	End
6	ITB	1st ITB Meeting	accomplished	2/12/2005	2/12/2005
10	ITB	NiSIS Roadmap	accepted/running	2/1/2005	1/31/2008
41	ITB	3rd ITB Meeting	accomplished	10/3/2005	10/3/2005
42	ITB	2nd ITB Meeting	accomplished	6/22/2005	6/22/2005
52	ITB	4th ITB Meeting	accomplished	11/30/2005	11/30/2005
56	ITB	5th ITB Meeting	accomplished	1/19/2006	1/19/2006
58	ITB	Brainstorming Meeting Majorca	accomplished	6/8/2006	6/9/2006
60	ITB	Survey on on-going Projects and European and National Initiatives	accomplished	2/1/2005	3/31/2007
61	ITB	Self Assessment Report	accomplished	2/1/2005	12/31/2007
63	ITB	6th ITB Meeting	accomplished	3/9/2006	3/10/2006
66	ITB	7th ITB Meeting	accomplished	6/9/2006	6/9/2006
86	ITB	8th ITB Meeting	accomplished	10/2/2006	10/3/2006
92	ITB	9th ITB Meeting	accomplished	11/30/2006	11/30/2006
96	ITB	10th ITB Meeting	accomplished	9/7/2007	9/7/2007
98	ITB	Grand Challenges & Impact Meeting	accomplished	9/6/2007	9/7/2007
124	ITB	11th ITB Meeting	accomplished	11/28/2007	11/28/2007
7	MGM	NiSIS Kick-off Meeting	accomplished	3/4/2005	3/5/2005
8	MGM	1st Steering Committee Meeting	accomplished	2/11/2005	2/11/2005
9	MGM	2nd Steering Committee Meeting	accomplished	6/22/2005	6/22/2005
14	MGM	NiSIS Annual Symposium 2005	accomplished	10/3/2005	10/5/2005
15	MGM	1st Periodic Progress Report and Financial Report the the EC	accomplished	1/1/2006	2/28/2006
16	MGM	2nd Periodic Progress Report and Financial Report to the EC	accomplished	1/1/2007	2/28/2007
17	MGM	3rd Periodic Progress Report and Financial Report to the EC	accomplished	1/1/2008	2/28/2008
20	MGM	1st Publication of Proceedings of NiSIS2005	accomplished	10/1/2005	10/31/2005
40	MGM	3rd Steering Committee Meeting	accomplished	10/4/2005	10/4/2005
44	MGM	Survey - What are the Industrial Challenges for Future Information Systems	accomplished	2/1/2006	6/30/2006
46	MGM	WEB-Site	accepted/running	10/5/2005	1/1/2008
57	MGM	4th Steering Committee Meeting	accomplished	1/19/2006	1/19/2006

74	MGM	2nd NiSIS Annual Symposium 2006	accomplished	11/29/2006	12/1/2006
75	MGM	5th Steering Committee Meeting	accomplished	6/9/2006	6/9/2006
94	MGM	7th SC Meeting	accomplished	2/22/2007	2/22/2007
97	MGM	6th SC Meeting	accomplished	11/30/2006	11/30/2006
99	MGM	3rd NiSIS Annual Symposium 2007	accomplished	11/26/2007	11/28/2007
120	MGM	8th Steering Committee Meeting	accomplished	9/6/2007	9/6/2007
123	MGM	9th Steering Committee Meeting	accomplished	11/28/2007	11/28/2007
125	MGM	Dissemination on raising public Participation and Awareness	accomplished	8/1/2007	12/31/2007
126	MGM	10th Steering Committee Meeting	accomplished	1/30/2008	1/30/2008
1	NiDT	1st NiDT Committee Meeting	accomplished	5/27/2005	5/28/2005
28	NiDT	"Natural Computing" A Special Issue on Nature-inspired Data Mining	cancelled	6/1/2005	1/31/2008
29	NiDT	Survey of Natural-inspired Data Technologies	accomplished	6/1/2005	12/1/2006
30	NiDT	Edited book on Natural-inspired Data Technologies	cancelled	6/1/2005	1/31/2008
32	NiDT	Task Force on Neural-inspired Combinatorial Machine Learning	accomplished	10/1/2005	9/30/2006
38	NiDT	Task Force on Nature-inspired Self healing Soft Sensors for Process Industry	accomplished	10/1/2005	9/30/2006
39	NiDT	Task Force on Nature-inspired Cooperative Strategies for Optimization	accomplished	10/1/2005	9/30/2006
43	NiDT	2nd NiDT Committee Meeting	accomplished	12/1/2006	12/1/2006
68	NiDT	Special Issue "Bioinformatics and Bio-inspired Models"	cancelled	3/1/2006	12/31/2007
80	NiDT	Task Force: Physically-inspired Artificial Learning Models - PIALM	accomplished	10/1/2006	12/31/2007
81	NiDT	Task Force: Nature-inspired Methods for Local Pattern Detection	accomplished	10/1/2006	12/31/2007
91	NiDT	Special Session at KES 2006 on Nature-inspired Data Mining	accomplished	10/9/2006	10/11/2006
111	NiDT	Grand Challenge Workshop 2007	accomplished	9/6/2007	9/7/2007
112	NiDT	Final Symposium Workshop	accomplished	11/26/2007	11/28/2007
113	NiDT	Workshop during NiSIS 2006	accomplished	12/1/2006	12/1/2006
116	NiDT	Student Exchange and Training: Nature-inspired Optimization for Machine Learning	accomplished	6/1/2007	12/1/2007
121	NiDT	Task Force Continuation - Nature-inspired Self healing Soft Sensors for Process Industry	accomplished	3/1/2007	12/31/2007
3	NiMOC	Spring School on Reverse Engineering in Systems Biology	accomplished	6/9/2005	6/9/2005
11	NiMOC	NiMOC Committee Meeting 2005	accomplished	10/4/2005	10/4/2005
12	NiMOC	Workshop on Reverse Engineering in Systems Biology	accomplished	6/10/2005	6/10/2005
13	NiMOC	Workshop at NiSIS2005 Annual Symposia	accomplished	10/3/2005	10/5/2005
18	NiMOC	Student Exchange "Modelling and Identification of Dynamic Gene Interactions	accomplished	5/1/2005	5/31/2005

19	NiMOC	Special Issue of Scientific Journal	accomplished	4/1/2005	5/31/2007
23	NiMOC	Task Force on Nature-inspired Monitoring and Control	accomplished	10/1/2005	9/30/2006
47	NiMOC	Survey for Nature-inspired Modeling, Optimization and Control	accomplished	11/1/2005	2/28/2006
49	NiMOC	NiSIS/JCB Spring School 2006	accomplished	5/4/2006	5/4/2006
50	NiMOC	NiSIS/JCB Workshop 2006 in Jena	accomplished	5/5/2006	5/5/2006
51	NiMOC	Case Study: Contributions to Modeling and Identification of Biomedical Systems	accomplished	10/1/2006	1/31/2007
59	NiMOC	NiMOC Workshop 2006 on Tenerife	accomplished	11/29/2006	12/1/2006
62	NiMOC	Task Force on Nature-inspired Robustness	accomplished	10/1/2006	12/31/2007
72	NiMOC	Workshop Knowledge Discovery and Emergent Complexity in BioInformatics (KDECB2006)	accomplished	5/10/2006	5/10/2006
77	NiMOC	Symposium on Mathematical Theory of Networks and Systems 2006 in Kyoto	accomplished	7/24/2006	7/28/2006
79	NiMOC	Task Force: Multitasking of Liver Tissue	accomplished	10/1/2006	12/31/2007
87	NiMOC	Spring School on Integrative Analysis of Transcriptome and Proteome Data	accomplished	3/15/2007	3/15/2007
88	NiMOC	Workshop Data and Knowledge Based Biomolecular Network Reconstruction	accomplished	3/16/2007	3/16/2007
89	NiMOC	Summer School Physiological Variables	accomplished	5/2/2007	5/3/2007
109	NiMOC	Grand Challenge Workshop 2007	accomplished	9/6/2007	9/7/2007
118	NiMOC	Final Symposium Workshop	accomplished	11/26/2007	11/28/2007
2	NiN	1st NiN Committee Meeting	accomplished	5/3/2005	5/3/2005
31	NiN	Research Exchange	accomplished	5/15/2005	6/15/2005
33	NiN	Task Force on The Origin Adaptability in Natural Networks	accomplished	10/1/2005	9/30/2006
34	NiN	Task Force on Potential Nature-inspired Aspects in Information Networks	accomplished	10/1/2005	9/30/2006
35	NiN	2nd NiN Committee Meeting	accomplished	10/5/2005	10/5/2005
54	NiN	Workshop at the AISB Conference Bristol	accomplished	4/4/2006	4/6/2006
76	NiN	Task Force on Sparking New Ideas through Brain-Like Association Networks	accomplished	10/1/2006	9/30/2007
107	NiN	Grand Challenges Workshop 2007	accomplished	9/6/2007	9/7/2007
110	NiN	Final Symposium Workshop	accomplished	11/26/2007	11/28/2007
114	NiN	3rd NiN Committee Meeting	accomplished	11/29/2006	11/29/2006
115	NiN	Student Exchange: Mind-inspired Methods to fight Digital Obesity	accomplished	5/1/2007	1/31/2008
122	NiN	Workshop on Nature-inspired Soft Computing in Large Networks	accomplished	7/23/2007	7/26/2007
24	TTE	Comparative Workshop NiSIS and EU Industry	accomplished	10/5/2005	10/5/2005
25	TTE	TTE Contribution to the Roadmap: Industrial Technology Transfer in NiSIS Roadmap	accomplished	2/1/2005	1/31/2008
36	TTE	NiSIS Benchmark Competition	accomplished	11/1/2005	1/31/2007
55	TTE	NiSIS Glossary and Dictionairy	accepted/running	12/1/2006	12/31/2007
64	TTE	TTE Self Assessment	accomplished	3/1/2005	5/31/2007

65	TTE	Cooperation with IP CLIA Joined Competition	cancelled	2/1/2007	12/1/2007
73	TTE	TTE Management 2th year	accomplished	2/1/2006	1/31/2007
83	TTE	Task Force: Immune System Inspired Health Monitoring of Machinery using the Danger Theory	accomplished	10/1/2006	12/31/2007
100	TTE	Best Practise Guidelines	accomplished	4/1/2006	1/31/2008
101	TTE	NiSIS Learning Centre	cancelled	7/1/2006	1/31/2008
102	TTE	Special Session at NiSIS 2006: Pap-smear benchmark	accomplished	11/30/2006	11/30/2006
104	TTE	Analysis of Human Community Dynamics Inspired by Nature	accomplished	10/1/2006	9/30/2007
105	TTE	TTE Self Assessment and Management	accomplished	2/1/2007	1/31/2008
106	TTE	NiSIS Team Competition 2007	accomplished	8/1/2007	1/31/2008
108	TTE	Final Symposium Workshop	accomplished	11/26/2007	11/28/2007
117	TTE	Development of PSO Methods - Student Exchange and Training	accomplished	10/1/2006	12/31/2006
119	TTE	FSCS 2006 - Symposium on Fuzzy Systems in Computer Science	accomplished	9/27/2006	9/28/2006
128	TTE	Workshop "Assessing Risks in Industry" at NiSIS 2007	accomplished	11/26/2007	11/26/2007

4.2 Analysis of costs per focus group

In this table all costs per focus group/area have been summarised to give a breakdown overview.

The definition of each area/focus groups is as follows:

NiN	Nature-inspired Networks
TTE	Technology Training and Education
NiMOC	Nature-inspired Systems, Modelling, Optimisation and Control
NiDT	Nature-inspired Data Base Technology
ITB	Integration Technology Board
MGM	Management

Area	2005 in €	2006 in €	2007 in €
TTE	14921	14207	29414,84
NIN	7098	17400	31480,578
NiMOC	19474	34236	51038,246
NiDT	20152	37118	56525,672
ITB	5656	132178	69620,33
MGM	157669	137668	189083,93

4.3 Analysis of costs per activity and year:

Here you can see how much was spent in total for each activity per year during the project life time:

Activity name	ID	2005 in €	2006 in €	2007 in €
1st NiDT Committee Meeting	1	5368	13	0
1st NiN Committee Meeting	2	2593	0	0
Spring School on Reverse Engineering in Systems Biology	3	4230	0	0
1st ITB Meeting	6	650	1252	0
NiSIS Kick-off Meeting	7	10823	943	0
1st Steering Committee Meeting	8	2612	733	0
2nd Steering Committee Meeting	9	1453	0	0
NiSIS Roadmap	10	16054	50026	62643
NiMOC Committee Meeting 2005	11	1242	0	0
Workshop on Reverse Engineering in Systems Biology	12	5475	0	0
Workshop at NiSIS2005 Annual Symposia	13	1054	0	0
NiSIS Annual Symposium 2005	14	31068	1775	1531
Personel/Management	15	63585	70259	75711
Special Issue of Scientific Journal	19		0	3600
Task Force on Nature-inspired Monitoring and Control	23	861	8930	0
Comparative Workshop NiSIS and EU Industry	24	3653	0	0
TTE Contribution to the Roadmap: Industrial Technology Transfer in NiSIS Roadmap	25	4422	5000	0
“Natural Computing” A Special Issue on Nature-inspired Data Mining	28	0	600	1574
Survey of Natural-inspired Data Technologies	29	5408	1253	0
Research Exchange	31	5988	0	0
Task Force on Neural-inspired Combinatorial Machine Learning	32	2745	7310	0
Task Force on The Origin Adaptability in Natural Networks	33	0	5002	0
Task Force on Potential Nature-inspired Aspects in Information Networks	34	0	3818	0
2nd NiN Committee Meeting	35	947	678	
NiSIS Team Competition 2006	36	0	10053	2705
Task Force on Nature-inspired Self healing Soft Sensors for Process Industry	38	0	7387	0
Task Force on Nature-inspired Cooperative Strategies for Optimization	39	0	13528	17753
3rd Steering Committee Meeting	40	0	925	0
3rd ITB Meeting	41	3763	769	0
2nd ITB Meeting	42	2587	1556	0
2nd NiDT Committee Meeting	43	751	3455	5169
Survey - What are the Industrial Challenges for Future Information Systems	44	3493	2882	0
WEB-Site	46	33228	32501	39076
Survey for Nature-inspired Modeling, Optimization and Control	47	3000	0	0

NiSIS/JCB Spring School 2006	49	0	1719	0
NiSIS/JCB Workshop 2006 in Jena	50	0	5390	0
Case Study: Contributions to Modeling and Identification of Biomedical Systems	51	0	5000	5000
4th ITB Meeting	52	2606	593	0
Workshop NiN	54		704	0
NiSIS Glossary and Dictionairy	55	300	300	0
5th ITB Meeting	56	979	572	0
4th Steering Committee Meeting	57	671	0	0
Brainstorming Meeting Mallorca	58	852	33869	0
NiMOC Workshop 2006 on Tenerife	59		5508	1733
Task Force on Nature-inspired Robustness	62		723	9990
6th ITB Meeting	63	263	4058	0
TTE Self Assessment 1st year	64	1304	0	0
7th ITB Meeting	66	0	4140	
Special Session on Nature-inspired Data Technologies and Special Issue on "Bioinformatics and Bio-inspired Models"	68	0	2191	3365
Workshop Knowledge Discovery and Emergent Complexity in BioInformatics (KDECB2006)	72	0	1115	1069
TTE Self Assessment 2nd year	73	0	2590	0
NiSIS Annual Symposium 2006	74	0	38268	14885
Task Force on Sparking New Ideas through Brain-Like Association Networks	76	0	3189	8176
Symposium on Mathematical Theory of Networks and Systems 2006 in Kyoto	77	0	2253	0
Task Force: Multitasking of Liver Tissue	79	0	7200	4560
Task Force: Physically-inspired Artificial Learning Models - PIALM	80	0	2320	8476
Task Force: Nature-inspired Methods for Local Pattern Detection	81	0	0	11999
Task Force: Immune System Inspired Health Monitoring of Machinery using the Danger Theory	83	0	0	3381
8th ITB Meeting	86	0	8905	
Spring School on Integrative Bioprocess Analysis and Modeling in Systems Biology	87	0	0	5500
Workshop on Integrative Bioprocess Analysis and Modeling in Systems Biology	88	0	0	6649
Adaptive Control of Anesthesia	89	0	0	7152
Special Session at KES 2006 on Nature-inspired Data Mining	91	0	2286	0
9th ITB Meeting	92	0	4275	0
Grand Challenges Meeting	98	0	0	4586
NiSIS Annual Symposium 2007	99	0	0	30620
Best Practise Guidelines	100	0	0	2400
Benchmark Workshop	104	0	1500	0
NiSIS Team Competition 2007	106	0	0	21251
Grand Challenge Workshop 2007	107	0	0	2224
Final Symposium	108	0	0	830
Grand Challenge Workshop 2007	109	0	0	2086
Final Symposium	110	0	0	18960
Final Symposium	112	0	0	1300
NiDT Workshop 2006 on Tenerife	113	0	612	0
NiN Workshop 2006 on Tenerife	114	0	1563	0

Student Exchange Genua - Prag	116	0	2024	2343
Final Symposium Workshop	118	0	0	2400
Task Force Continuation - Nature-inspired Self healing Soft Sensors for Process Industry	121	0	0	4535
Workshop on Nature-inspired Soft Computing in Large Networks	122	0	0	2250
11th ITB Meeting	124	0	0	2386
Dissemination on raising public Participation and Awareness	125	0	0	22800
10th Steering Committee Meeting	126	0	0	1082

4.4 Analysis of costs per activity by each partner

Here you can see how much was spent in total by each partner:

No	Name	2005 in €	2006 in €	2007 in €
70101	ELITE European Laboratory for Intelligent Techniques Engineering	152683	186231	230734,356
70102	The University of Sheffield, Department of Automatic Control & Systems Engineering	0	26484	10592,55
70103	Bournemouth University Higher Education Corporation, School of Design, Engineering and Computing	5237	6647	5506,88
70104	Erasmus Universiteit Rotterdam, School of Economics, Department of Computer Science	1232	927	2707,5
70105	Steinbeis GmbH & Co für Technologietransfer	11105	8467	3312,24
70107	The University of Bristol, Artificial Intelligence Group, Dep. of Engineering Mathematics	4612	3982	19780,63
70109	University of Oulu, Control Engineering Laboratory	1000	4242	6597,6
70111	Danmarks Tekniske Universiteit, Dep. of Automation	1211	980	
70112	Hans-Knöll-Institute for Natural Products Research, Dep. for Applied Microbiology	2963	7451	2012,05
70113	Universiteit Maastricht, Dept. of Mathematics,	1313	4015	5781,72
70115	BioControl Jena GmbH	13977	10511	18519,12
70116	University of the Aegean, Financial and Management Engineering	1254	0	3361,32
70117	Universita degli Studi di Genova, DIBE-Department of Biophysical and Electronic Engineering	8927	14740	8499,54
70118	British Telecommunications plc, Research and Venturing, Future Technologies Group	0	5099	9947,77
70119	University of Twente	237	4849	
70121	Czech Technical University in Prague, Dep. of Cybernetics, Faculty of Electrical Engineering	2368	6761	4228,21
70127	Université Pierre et Marie Curie Paris	5988	0	
70128	University of Natural Resources & Applied Life Sciences, Department of Biotechnology	1221	6189	0
70129	Otto-von-Guericke Universität Magdeburg,	4077	16205	20440,26
70130	Faculdade de Ciencias da Universidade de Porto	1231	6116	12916,93
70999	ELITE European Laboratory for Intelligent Techniques Engineering	4986	53060	62224,92