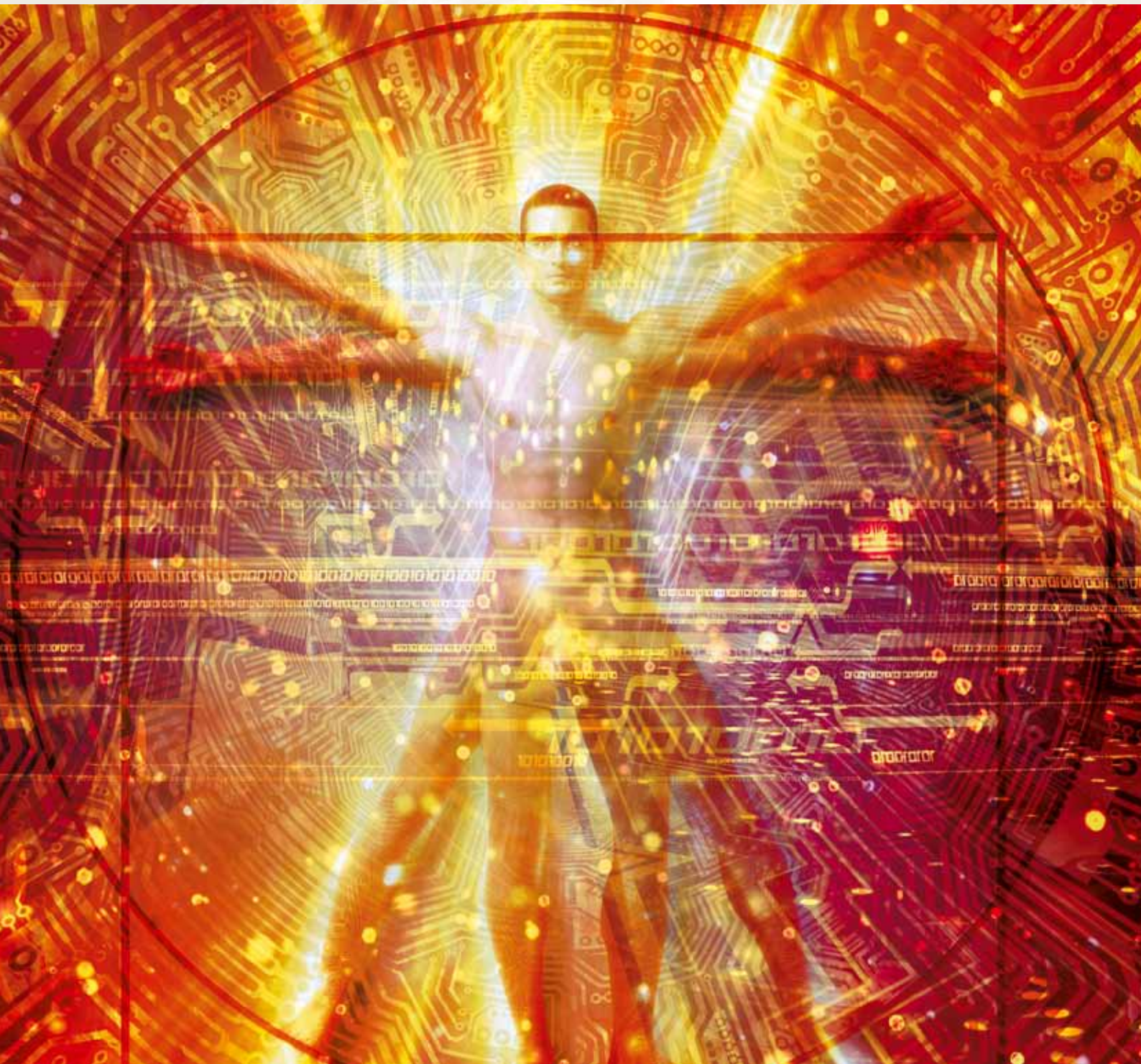


Nordic eScience Action Plan

10 concrete actions to implement the Nordic eScience Strategy



Nordic eScience Action Plan
10 concrete actions to implement
the Nordic eScience Strategy

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Foreword

The importance and use of eScience is expanding world-wide, and now is the time to act together to establish our region, Norden, as a highly visible forerunner in this field.

Societies in the 21st century are facing an ever-increasing level of globalisation. For the traditional industrialised countries, this implies fierce pressure on economic competitiveness, often resulting in a perceived need to move from a physically-based to a more knowledge-based economy. A well-educated population, strong research environments, ever more ingenious innovation and a highly advanced information and communication technology (ICT) infrastructure, with accompanying applications, is crucial to this shift. Moreover, a strong *eScience* foundation is essential. The term *eScience* is used here to describe the application of advanced ICT in research, the use of global collaboration within key areas of science and the development of the next generation of ICT infrastructure that will enable these activities. To the traditional two pillars of scientific investigation – *observation* and *theory* – *eScience* adds a third pillar consisting of *calculation, simulations and modelling*.

The Nordic countries are all strategically engaged in managing globalisation and the shift to a knowledge-based economy. But more needs to be done, and in cooperation with others. The relatively small size of the Nordic countries combined with our general similarity and common understanding on a vast number of issues, implies that it must be among the Nordic countries that we seek our partners, when cooperative and coordinated actions are to be undertaken – in this case within *eScience*. Hence, *eScience* experts and policy strategists call for increased Nordic cooperation on *eScience* within three areas: *Education, Research and ICT infrastructure*. Through jointly developed education programmes, we need to better prepare the future workforce and researchers in the use of *eScience* tools such as the vast, ever-increasing, globally scattered databases and the High Performance Computing facilities used for calculation, simulations and modelling. Significant areas within the Nordic countries already using

such *eScience* tools span molecular medicine, global climate change modelling, oil and gas exploration, atomic scale material design and welfare research. We must design policies and instruments to allow easy and open access to data repositories, across both thematic and country borders. Through joint research programmes we must be brought to better understand the optimal utilisation of such *eScience* tools – and develop them further than anyone else. By jointly developing new or sharing existing expensive ICT research infrastructure, we must provide the best possible preconditions for our *eScience* based research and education.

Such actions are needed if we are to adapt and advance ourselves in the ever-tougher global competition, and hence be able to maintain and develop the prosperity upon which the Nordic countries are built. While retaining the option of maintaining our central characteristics, we must at the same time remain open to outside change and influences. We must, knowledgeable of the times ahead, steer our societies into the future, before the state of affairs imposes upon us an economic and societal impoverished reality.

The importance and use of *eScience* is expanding world-wide, and now is the time to act together to establish our region, *Norden*, as a highly visible forerunner in this field. We must aim to make ourselves the world's most attractive region in terms of an enabled, educated population and a workforce for the 21st century that can pave the way for multidisciplinary knowledge production and innovations of a completely new type.

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Introduction

“eScience will revolutionise the way science is undertaken in the 21st century.”

eScience is about developing and applying advanced tools within information and communication technology (ICT) in order to exploit a new mode of advancing research, complementing theory and experiments. eScience is also about global collaboration within key areas of science, and about the next generation of infrastructures that will enable it. eScience infrastructures include computer networks, high performance computing and visualisation systems, federated databases, and network-enabled research instrumentation. It also includes ICT Grids – the distributed computing technology that provides access to remote resources and enables collaboration among distributed virtual organisations. Such collaboration, which often requires cross-disciplinary research teams, vast data collections, very large-scale computing resources and high-speed networks, will revolutionise the way science is undertaken in the 21st century. Depending on the field of research, eScience methods can act as a test bed for new models, a fully controllable virtual laboratory experiment, a numerical microscope, or a number-crunching analysis toolbox. Now is a timely opportunity for the Nordic countries to strengthen the competitiveness and visibility of

Nordic eScience based research across all disciplines, to promote innovative service-oriented business models and to advance Nordic knowledge-based industry.

In 2006, the Nordic Council of Ministers formed an ad hoc eScience Work Group assigned to propose a joint Nordic eScience strategy. The Work Group delivered its report ¹ in July 2007, emphasising the need for long-term, sustainable collaborations within Nordic eScience infrastructures and proposing new Nordic eScience programmes within research, infrastructure and education. This initiative was taken further by the research councils of Denmark, Finland, Sweden, Iceland and Norway under NordForsk's NORIA-net instrument, forming *The Nordic eScience Initiative* (eNORIA). In the course of their work, the participants of eNORIA were asked by the Nordic Ministers for Education and Research (MR-U) to propose an action plan to realise the Nordic eScience strategy.

This document constitutes the Action Plan proposed by the group. Its purpose is to motivate and describe concrete lines of actions that would be necessary to implement an integrated Nordic eScience strategy covering higher education, research and ICT infrastructure.

Mission and Objectives

“These objectives will inspire new collaborations and produce unforeseen opportunities for Nordic research and innovation.”

Taking its point of departure in the strategy of the Nordic Ministers for Education and Research (MR-U), approved on 17 September 2007, the mission of this Action Plan is to develop eScience into a Nordic flagship cooperation area. This Action Plan suggests eScience related actions are taken within 3 action lines: A) **higher education**, B) **research** and C) **ICT infrastructure**. The Action Plan sets out perspectives and objectives for 10 specific actions, within cooperation areas where added value is perceived to be the greatest and where the organisational framework is understood to be well in place and mature for Nordic cooperation. These include:

- A. Joint development and implementation of eScience education at the Bachelor and Master levels; and joint training of PhDs and young researchers in eScience tools and methods.
- B. Developing national eScience research programmes, sharing experiences and cooperating within a Nordic eScience research programme that can stimulate Nordic participation in global scientific *grand challenges*.
- C. Sharing eScience infrastructure through common database policies, sharing scientific data as well as sharing or jointly owning expensive high performance computing installations.

The work towards these objectives will inspire new collaborations, building cross-disciplinary communities of professionals who will produce unforeseen opportunities for research and innovation in the region of the Nordic countries.

Organisational framework for Nordic eScience Cooperation

To ensure the best possible coherence and uniformity of efforts, it is important to establish a good organisational framework when aiming to implement suggested actions. This means engaging existent structures and building new ones where they are needed. The areas covered in this Action Plan – *Higher Education, Research and ICT infrastructure* – have already, to a large extent, their Nordic organisational framework in place. These organisations will be engaged in the implementation of the proposed actions.

Under the auspices of the Nordic Council of Ministers, the Ministers of Education and Research in the Nordic countries and autonomous areas (MR-U) share overall responsibility for education and research cooperation. The Committee of Senior Officials for Education and Research (EK-U) prepares the agenda for the Ministers' meetings and follows up on their decisions. Each main policy area has an advisory committee in charge of development initiatives and advising the ministers. The Advisory Committee on Higher Education (HØGUT) is the advisory body for the Nordic Council of Ministers on higher education. HØGUT's role is to strengthen and develop Nordic cooperation in the education community at all higher education levels at universities and colleges. The Nordic Council of Ministers funds Nordic Master Programmes to encourage higher education providers in the Nordic countries to work together to draw up robust and attractive joint master programmes. Furthermore, the Nordic Council of Ministers runs the Nordplus Framework Programme to promote quality and innovation in the education systems in the Nordic and Baltic countries by supporting mobility, intensive courses and networking.

NordForsk is an independent Nordic research institution under the Nordic Council of Ministers for Education and Research (MR-U); responsible for Nordic collaboration in research and research training. NordForsk has several instruments with relevance to this Action Plan, such as research programmes, research schools and Centres of Excellence. NordForsk also has a natural

responsibility for Nordic infrastructure collaboration, having taken recent initiatives to promote joint Nordic use, stimulate interaction and facilitate planning of new projects.

NORDUnet is an infrastructure collaboration between the Nordic national networks for research and education. NORDUnet interconnects these networks and connects them to the worldwide network for research and education and to the general-purpose Internet. NORDUnet has responsibility for the research network infrastructure. On the national level, responsibilities are shared between the Ministries for Education and Research, the research councils and the national providers of eScience infrastructure. The national ministries have the principal responsibility for ensuring unified national eScience policies and accompanying action, their respective research councils being instrumental to progress along the *research* and *ICT infrastructure* action lines. Higher Education policy is typically in the hands of the ministry, but implemented by universities. The provision of eScience *ICT infrastructure* (research networks, high performance computing and services) is funded directly by the Ministry of Education and Research, the National Research Council or a combination of these two. Each country has at least one national eScience infrastructure provider responsible for this type of research infrastructure.

It follows that the action line on creating a higher education arena for eScience is a shared responsibility of NCM and NordForsk (research school). The action line on enabling research into grand challenges is a responsibility of NordForsk and the national research councils, while the actions on infrastructure should be dealt with through NordForsk and the national eScience infrastructure providers.

Three Action Lines Comprising Ten Concrete eScience Actions:



Action Line A. Creating a Nordic Higher Education Arena for eScience

In the Nordic countries, there are already several examples of successful educational programmes in eScience. However, because of the rapid growth of the eScience field, the number of leading eScience lecturers in each country is limited, and the national initiatives normally focus on certain educational levels or specific subject fields. The potential of using the experience gained from the early national initiatives, by joining and sharing experiences across the Nordic countries, is significant. The introduction of leading eScience education programmes at the Nordic level will give Nordic research a broad competitive advantage, providing graduates who are prepared to improve the use of eScience techniques in research fields where such methods are used today, and for introducing such techniques in fields of science where new computational methods may have immense impact. Also, such programmes will provide Nordic industry with the technology experts of the 21st century, skilled in the advanced computing technologies that are the foundation for emerging service-oriented business models and knowledge-based industry. Within five years, the goal of the education action line is to establish a highly competitive, attractive and visible Nordic curriculum for eScience education, covering the entire spectrum from basic Bachelor level courses to advanced researcher training.

The first step includes initiating a Nordic Master and PhD programme. This programme will draw on the current successful national eScience educational initiatives to develop specialised courses for an up-scaled student mass that covers all Nordic countries. The focus of these programmes will be to produce graduates with skills in a variety of disciplines in science and technology, combined with a broad knowledge of modern eScience techniques. Also, the programmes will encourage interdisciplinary work and assist in spreading the use of eScience methods into new areas of research. The courses in the programme should be specifically developed by leading expertise, tailored to acknowledge the varying backgrounds of the students, and given in a format to allow students from all over the region to participate. A revision of the current incentive system (course credits earned locally) should be considered to encourage universities to send students out. With eScience methods finding their way into almost all disciplines, students may also benefit greatly from being introduced to eScience techniques as early as the Bachelor level. The Action Line on Bachelor, Master and PhD education will be initiated within the frameworks of the Nordplus Framework Programme, the Nordic Master Programme and the NordForsk research schools, respectively.

“The eScience education programmes will provide Nordic industry with the technology experts of the 21st century.”

ACTION 1. Training Researchers in eScience Tools and Methods

A pilot project will be initiated to establish the framework for a Nordic research (PhD level) school in eScience. The purpose of the research school is to develop and offer courses to PhD students of short duration on eScience subjects given by expert Nordic or international lecturers. The research school will also enhance mobility of PhD students.

COMMENCEMENT: 2010
IMPLEMENTATION: 2010 – 2012
RESPONSIBLE: NordForsk

ACTION 2. A Nordic eScience Masters Education

Higher education providers will be encouraged to apply for a pilot project designed to result in the introduction of a Nordic Master Programme in eScience. Collaboration on a Nordic Master in eScience may pool expertise across the countries, thereby offering increased focus to an enlarged body of students. Applications should be submitted to the Nordic Council of Ministers' call process for Nordic Master Programmes to ensure a coherent assessment of quality.

COMMENCEMENT: 2009
IMPLEMENTATION: 2010 – 2011
RESPONSIBLE: The Nordic Council of Ministers

ACTION 3. Sharing and Specialising Nordic eScience Educational Modules

A support programme will be initiated to develop eScience course modules that can be exchanged across the Nordic countries. Such educational modules will be developed from the Bachelor level and up. The purpose is to introduce students to eScience concepts as part of established courses across a wide range of disciplines. The Nordplus Framework Programme may be a suitable instrument for facilitating this action.

COMMENCEMENT: 2010
IMPLEMENTATION: 2010 – 2011
RESPONSIBLE: The Nordic Council of Ministers

ACTION 4. Fostering Nordic eScience Collaboration through Mobility

In order to build a tighter Nordic eScience community, a mobility programme will be formed to support shorter visits for students and young researchers. This will be important to foster Nordic collaborations and particular attention will be given to the promotion of networking for young people. This action will be coordinated within the Nordplus Framework Programme, which has long experience within related activities.

COMMENCEMENT: 2010
IMPLEMENTATION: 2010 – 2012
RESPONSIBLE: The Nordic Council of Ministers



Action Line B.

National and Nordic eScience Programmes in Pursuit of Grand Challenges

The five-year goal for the action line on eScience research is to strengthen Nordic participation in breakthroughs in selected global scientific *Grand Challenges*, comprising the most capable combination of scientific competence and ICT Infrastructure assets available to Nordic researchers. A Grand Challenge problem is understood here as one for which the solution will have significant scientific, economic or social value but, at the same time, cannot be solved in a reasonable amount of time with today's scientific ICT instruments and without engaging the totality of global elite research collaboration. Potent Nordic ICT Infrastructures include High Performance Computing (HPC) resources, visualisation facilities, databases and repositories, high-speed Internet connections, as well as the tools, services and manpower needed for direct flexible access to these resources.

In the *Nordic Computational Grand Challenge Survey*² carried out in 2007, Nordic researchers posed 34 such research challenges, in which a major effort within eScience promises great scientific progress, innovative potential or societal value. Proposals ranged from astrophysics and climate computing to tsunami propagation, biomedicine and computations for nanotechnology. This opportunity was noted in the Nordic eScience Strategy, which suggested a research programme to address some of these Grand Challenges. These challenges will need to be approached both through national and joint Nordic efforts.

“The research programme will address scientific problems where eScience may accelerate the research cycle, and where Nordic collaboration and coordination may provide added value”.

ACTION 5. A Nordic eScience Programme for Research into Grand Challenges

A joint research programme will be established to address scientific problems where eScience may accelerate the research cycle, and where Nordic collaboration and coordination may provide added value. Projects within this Nordic research programme may address such grand challenges, where improvements of methodologies, together with deeper understanding of the questions at hand, are required for success. Projects may involve large volumes of data, which may be distributed over several locations, and/or involve extreme resources in terms of computing capacity. Development of new models and algorithms, software tools and services can be included as elements of those projects, but not funded as stand-alone projects.

The programme has an indispensable specific support action in terms of a joint infrastructure component, involving allocation of the required HPC and storage resources for funding awarded to grand challenge research by the programme. These HPC and storage resources will be allocated through Action Line C, Action 9 – Implementing Cross-Border Sharing of Resources. The research programme will be coordinated by NordForsk with a programme committee appointed by the national research councils.

COMMENCEMENT: 2010
IMPLEMENTATION: 2010 – 2014
RESPONSIBLE: NordForsk and the national research councils

ACTION 6. Strengthening National eScience Initiatives

National plans for strengthening eScience research will be established in each country to ensure synergies with the eScience advancements on the Nordic level. Such initiatives are essential for ensuring assimilation of eScience developments, but also to provide the foundation for the joint Nordic research effort. The format of these plans will depend on the current national status of eScience research, since some countries have initiated a national eScience effort while other countries have not yet taken a strategic approach to this area.

COMMENCEMENT: 2009
IMPLEMENTATION: 2009 – 2014
RESPONSIBLE: The national research councils



Action Line C.

Knowledge Creation through Cross-Border Sharing of eScience Infrastructure

This Action Plan supports the Nordic eScience Strategy's focus on *"...the need for long-term sustainable collaboration to maintain and develop Nordic eScience infrastructure"*. In this context, eScience infrastructure encompasses:

- Data Management – of the vast and ever growing datasets
- Computer Networks, i.e. dedicated, high speed, high quality Internet
- High Performance Computing, also called Supercomputers or Scientific Computing
- Grid Infrastructure – i.e. via Networks, connecting distributed HPC and Data resources

The provision of these infrastructure elements is organised differently in each of the Nordic countries with many well-developed modes of cooperation across organisational and national boundaries. The action line on eScience infrastructure will be pursued with a view to open access and EU policies, and efforts will complement relevant priorities within the EU framework programmes and the ESFRI roadmap.

The Nordic countries have comprehensive databases and data repositories owned by national authorities for administrative or monitoring purposes. No other part of the world has such comprehensive data, namely within the area of social sciences, the humanities. In addition, new valuable scientific data is collected and generated all the time – at an almost explosive rate. Most of these unique data structures are currently underused for research – more often than not, due to legal, organisational and policy restraints rather than technical. An important goal for the infrastructure action line is to enable the combined use of the existing national data-

bases and data repositories within selected research areas, as well as to initiate activities improving the possibility of using newly-generated scientific data. In so doing, the many non-technical restraints must be overcome. The lack of documentation calibration and validation of data records has been found problematic by both the OECD³ and the Council of the European Union⁴, which have released recommendations on data access and preservation.

The NCM ad hoc strategy workgroup also emphasised *"...the need for long-term sustainable collaboration to maintain and develop Nordic eScience infrastructures such as computer networks, High Performance Computing (HPC) resources and Grid infrastructure"*. As for computer networks, a successfully structured collaboration is already established through the joint Nordic NORDUnet organisation. During the past few years there has been a rapid development in Nordic Grid Computing infrastructure, and a joint Nordic Grid project (Nordic Data Grid Facility, NDGF⁵) has been established. Now the long-term aspects of this cooperation project needs attention. The Nordic HPC providers have a good working relationship, although mainly informal. Barely an issue just a couple of years ago, *"green computing"* is now in focus due to the immense and ever-growing energy regiments of HPC installations. The term is used to encompass both power efficiency and environmental responsibility. The overall ICT power consumption, already quite vast, is expected to grow by around 15 percent per year. With the pressure on computer centres to accommodate ever-larger HPC systems, energy conserving strategies have become a huge issue within HPC. The up-scaling of systems may call for new strategies on the Nordic scale, with a view to the developments on the European scene as proposed through the ESFRI roadmap.

ACTION 7. Open Access to National Data Repositories

A time-limited expert task force will be established to propose a plan for enabling combined use of the existing national databases and data repositories within selected research areas, and to initiate activities improving the possibility of using newly-generated scientific data. The task force will propose secure and efficient modes for accessing and processing the data collected by national authorities, and for merging them with research data from other sources. This will open up for new and unique research opportunities in the life sciences, earth sciences, social sciences, medicine and the humanities – research areas which have not traditionally been ICT driven. The task force will also propose the development of policies to address the political, administrative and legal barriers that need to be tackled to facilitate the shared use of these data sources.

COMMENCEMENT: 2010
IMPLEMENTATION: 2011 – 2012
RESPONSIBLE: NordForsk

ACTION 8. Facilitating Sustainable Grid Infrastructure Collaboration

The successful Nordic Data Grid Facility (NDGF) is funded jointly by four Nordic countries until 2010. To exploit the potential for future Grid collaboration in the Nordic countries, a time-limited expert task force will be responsible for providing a proposal for a sustainable Nordic Grid infrastructure collaboration beyond 2010. The proposal will describe which Nordic-level functions, services and organisation would be beneficial for coupling HPC and digital resources using Grid technologies.

COMMENCEMENT: 2009
IMPLEMENTATION: 2010 – 2011
RESPONSIBLE: NordForsk

ACTION 9. Implementing Cross-Border Sharing of Resources

The current informal Nordic high performance computing collaboration will be strengthened to allow for cross-border sharing of resources in support of the Nordic pursuit of scientific Grand Challenges, as proposed under the research action line, Action 1. The national eScience infrastructure providers will submit a proposal on how joint Nordic HPC, Grid and data-storage sharing can be organised and funded – guaranteeing that any research funded at the Nordic level (e.g. by NordForsk), which is in justifiable need of joint access to ICT infrastructure, also will be granted such access at the Nordic level.

COMMENCEMENT: 2010
IMPLEMENTATION: 2010 – 2012
RESPONSIBLE: National eScience infrastructure providers

ACTION 10. Environmentally-Friendly Nordic High Performance Computing

A pilot project will be initiated to establish a joint Nordic environmentally-friendly High Performance Computing (HPC) facility. An optimal location should offer comparatively cheap and renewable energy, and high quality Internet connectivity. The intention is to explore ways to dampen growth of the HPC carbon footprints, which are caused by the already excessive and ever-increasing power and cooling requirements of new HPC installations. A further aim is to pilot the international sharing of such costly and organisationally complex research infrastructures.

COMMENCEMENT: 2010
IMPLEMENTATION: 2010 – 2012
RESPONSIBLE: National eScience infrastructure providers

“An important goal is to enable the combined use of the existing national databases and data repositories within selected research areas.”

Endnotes

¹ http://www.norden.org/avtal/utbildning/sk/nordic_escience.pdf

² http://www.csc.fi/csc/julkaisut/vuosikertomukset_ja_raportit/ngcs

³ http://www.oecd.org/document/55/0,3343,en_2649_34293_38500791_1_1_1_1,00.html

⁴ http://ec.europa.eu/research/infrastructures/pdf/97236_en.pdf

⁵ <http://www.ndgf.org/>

Postscript

This Action Plan was commissioned on 29 April 2009 by the five Nordic Research and Education Ministers via the Nordic Council of Ministers for Education & Research (MR-U).

The Action Plan has been drafted by a group of research council appointees consisting of:

Guðmund Høst (Chairperson), The Research Council of Norway;
René Belsø, Danish Centre for Scientific Computing;
Sverker Holmgren, Swedish National Infrastructure for Computing;
Ebba Þóra Hvannberg, University of Iceland;
Pentti Pulkkinen, Academy of Finland.

Support from NordForsk: Erlendur Helgason.

The group has had consultations and meetings with a wide range of stakeholders through a number of events including:

- NordForsk
- The Academy of Finland
- The Danish Agency for Science, Technology and Innovation
- The Finnish IT Centre for Science (CSC)
- The Icelandic Centre for Research (RANNIS)
- The Icelandic Ministry of Education, Science and Culture
- The Joint Committee of the Nordic Research Councils for Natural Sciences (NOS-N)
- The Nordic Council of Ministers
- The Research Council of Norway
- The Swedish Research Council

The Action Plan was submitted to the Nordic Council of Ministers in November 2008.



Executive Summary

eScience is about developing and applying advanced tools within information and communication technology (ICT) in order to exploit a new mode of advancing research, complementing theory and experiments. eScience is also about global collaboration within key areas of science, and the next generation of infrastructures that will enable it. Collaborative efforts in eScience, across national borders and borders between research fields, are expected to revolutionise the way science is undertaken in the 21st century. By joining forces on the eScience arena, the Nordic countries may develop a current regional strength to the future benefit of a wide range of application areas within science, industry and society. Building on a recent eScience strategy initiated by the Nordic Council of Ministers, the Action Plan presents an integrated approach to Nordic eScience cooperation with 10 concrete actions along the lines of higher education, research and ICT infrastructure. The existing Nordic and national organisational framework is well-adapted to the implementation of the plan.