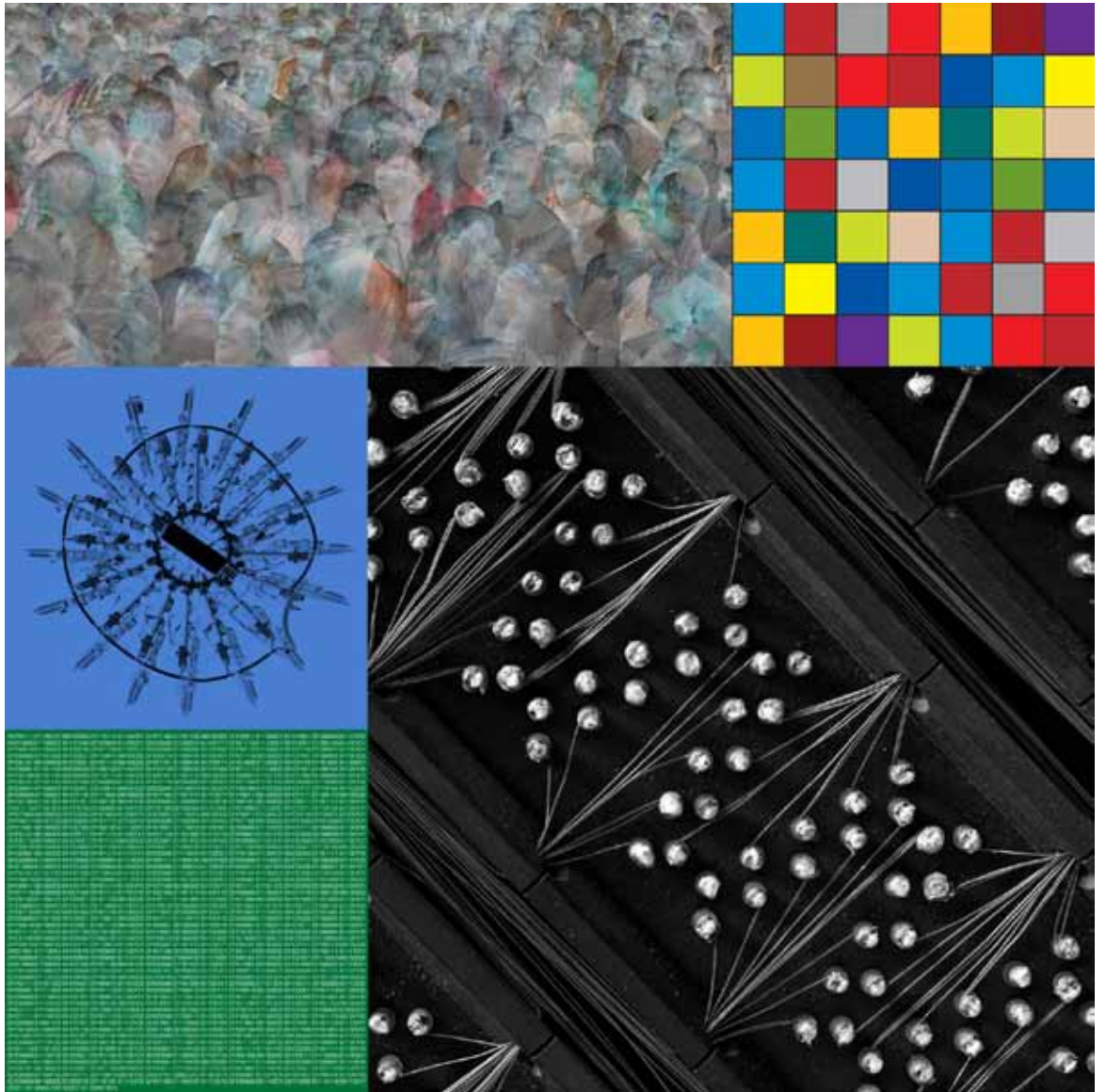


The Strategic Area

# Information and Communication Technology



Annual report 2010



**NTNU – Trondheim**  
Norwegian University of  
Science and Technology

## ICT in interdisciplinary research at NTNU



NTNU's ICT research must be nationally and internationally significant. Research should be of relevance to national objectives including its international and regional aspects.



*John Koppie*

The area has been organised to foster innovative research based on in-depth expertise in each basic field. Interdisciplinary programmes involving relevant subject specialists are designed to address the complex challenges that face Norwegian society along with many others. As important as bringing different subject specialists together is the integration of university research with work being done in industry and in other public institutions.

## Our goal is synergistic development through interaction

Norway's ICT industry is significant both nationally and locally in Trondheim. It must compete in the global market without the privileges of industries that are built on nationally controlled natural resources like the petroleum, fishing and energy industries. Nevertheless, Trondheim has been ranked amongst the 40 most important ICT sites in the world (Wired Magazine). The international GSM system was designed here. Companies like Atmel, Microsoft Fast, Telenor, Yahoo, Oracle and ARM-Falanx are located in town, mainly represented by R&D departments. A major part (65%) of all MSc and PhD candidates in ICT in Norway graduate from NTNU, allowing the university to cooperate with companies and institutions from all over Norway and abroad.

Moreover, the use of ICT is also a crucial factor for advances in other sciences, in industry, and in society in general. Top-quality basic ICT expertise is needed in order to deliver competitive solutions to user needs for any purpose. As such, ICT research at NTNU is closely connected to major Norwegian industries and the other strategic

research areas at NTNU. This close cooperation is of national importance.

Basic ICT research is managed by the departments of

- Engineering Cybernetics
- Electronics and Telecommunications
- Telematics
- Computer and Information Science
- Mathematical Sciences

The ICT thematic area enables interdisciplinary research within ICT and in various application areas for innovative use.

Brief descriptions of our research programmes can be found in this publication. More details are available at <http://www.ntnu.no/ikt/english>



*From ICT and Art to human sensors?*

## What are the Strategic Areas at NTNU?

One of the main objectives of the Norwegian University of Science and Technology (NTNU) is to provide Norway with know-how of international calibre. To realise this goal, NTNU has given priority to six strategic areas where we aspire to be among the leading international universities. These are:

- Energy and Petroleum
  - Resources and Environment
- Globalization
- Information and Communication Technology (ICT)
- Marine and Maritime Technology
- Materials
- Medical Technology

More at: [www.ntnu.edu/research/strategic\\_research\\_efforts](http://www.ntnu.edu/research/strategic_research_efforts)

One of the areas for innovation through application of ICT is where the creative and the playful man meet, in art. The thematic area of ICT highly appreciates the possibility to cooperate with artists as exemplified in the front picture of this brochure, entitled 'Everything is Information'.

- [upper left] Front cover: Artwork by Prof. Alex Booker *The crowd*. Superposition of identities, a digital afterimage.
- [upper right] Colour-encoded text: "Information is everything, everything is information"
- [centre right] Lower part of the first digital computer in Trondheim, Gier (1962). Photo: Kai Torgeir Dragland, NTNU.
- [centre left] Hypercube computer built at NTNU in 1985 at Department of Information and Computer Science (IDI) to test parallel database algorithms.
- [bottom left] Text-to-binary encoding. Butler's reflections upon global interconnectivity after the construction of the first telegraph line in New Zealand (1863).

All photo credits: Kai Torgeir Dragland (IDI, NTNU), unless otherwise specified.

## Overview of thematic programmes and staff

**Health Informatics:** 10 scientists and 24 postgraduates make up the core group. Other researchers in basic ICT and medicine are linked to the group.

**Bioinformatics:** 10 scientists and 12 postgraduates make up the core group. Other researchers in basic ICT and medicine are linked to the group.

**Learning with ICT (LIKT):** Approximately 10 scientists in different scientific departments are working with research issues related to learning with ICT.

**Language Technology:** 10 scientists and 12 postgraduate students make up the core group. Another 12 scientists and their PhD students are linked to the group.

**Computational Science and Visualisation:** Around 65 scientists and 50 PhD students apply advanced CSV in their research work in other disciplines. A core staff of 15 scientists and 22

postgraduates are working on generic infrastructure and numerical methods.

**eGovernment** around 5 scientists and 5 PhD make up the core group, but close cooperation with other programs such as health informatics enlarge the group vs. specific areas within the public sector.

**Computer Games:** 15 scientists, and 30 postgraduates make up the core group. Other researchers mainly in ICT, music technology and psychology are linked to the group.

**Robotics:** 14 NTNU professors make up the core group, together with 4 SINTEF researchers. Furthermore, both PhD students and postgraduates make up an important part of the group.

Staff (2010) in basic ICT departments FTE at the Faculty of Information Technology, Mathematics and Electrical Engineering				
Department:	Faculty (permanent)	Faculty (adjunct)	PhD Fellows	Postdoc fellows
Computer Science	44	8	56	4
Electronics and Telecommunication	31	8	52	7
Engineering Cybernetics	14	3	24	1
Mathematical Sciences	42	4	43	9
Telematics	13	2	14	1
Q2S	1	2	22	6
<b>Total</b>	<b>145</b>	<b>27</b>	<b>211</b>	<b>28</b>

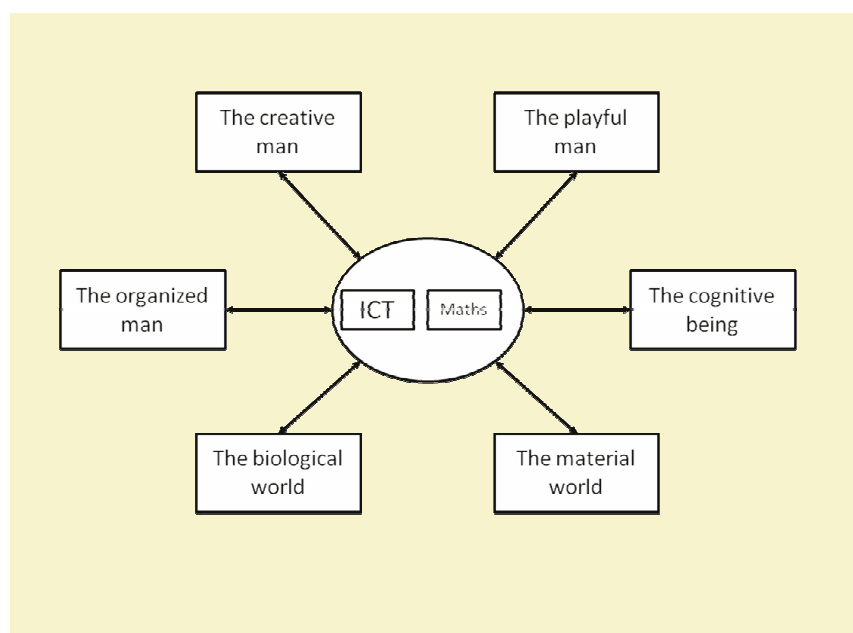
Many of the faculty and fellows are also involved in the ICT thematic programmes.

## Research Design

The ICT Strategic Area is organised with a focus on innovative ICT applications in other disciplines, along a number of dimensions as illustrated.

- The material world
- The biological world
- The cognitive being
- The organised man
- The creative man
- The playful man

When using ICT and mathematics in the innovation areas, the particular ways to represent and manipulate knowledge in our core areas enable new ways of representing knowledge in the innovation areas. The ways of representation used in the innovation areas can be pro-



Core areas and innovation areas

vided back to the core area, enriching the core discipline with techniques that might be used also in other fields.

In concrete cooperation within a field we are pursuing cooperation among the basic sciences providing a knowledge platform that allows us to tackle complex challenges. Examples of system products are telecommunications, health services and petroleum operations. We are addressing smaller and larger parts using an understanding (model) of the whole system product. The artefact "ultrasound equipment" operates with the environment "the body" in the context of a system of health care diagnostics and care. Similarly, the computer-generated model (artefact) of a petroleum reservoir (environment) is used to improve operations and enhance oil recovery in a petroleum province (the system product).

ICT is used in almost all public and private sectors to improve services and products. More than half of all planned new developments involve ICT. Most people are familiar with the various facets of ICT, from mobile phones, computers, the Internet, social software, and computer games, to the many visions of the future portrayed by the media. In Norway, ICT is the hub for improving quality and productivity in most sectors of society. Norway's oil and gas industry, health, public services, off-

shore and marine industries, communication and energy are the country's most important ICT users.

The various departments involved in ICT and the Faculty of Information, Technology, Mathematics and Electric Engineering have conducted a strategic exercise to harmonise shared objectives among the basic research groups and thematic programmes, under the various umbrellas of the departments and faculty. The overall guidelines drawn for the future development of ICT relate to the questions of how we:

- Build and operate very large and complex combined technical and human networks in most application areas, particularly with respect to interoperability, security, privacy and reliability.
- Make use of simulations and visualisations based on appropriate knowledge representations (models) to reproduce reality (as in petroleum reservoirs or use of ultrasound on the human body), construct reality (oil platforms), understand reality (climate models, genomics, etc.) and to control reality (process control).
- Support the knowledge-intensive cooperation between different people across different locations, mixing the support of social communities, virtual organisations and more traditional organisational form.
- Manage and exploit enormous

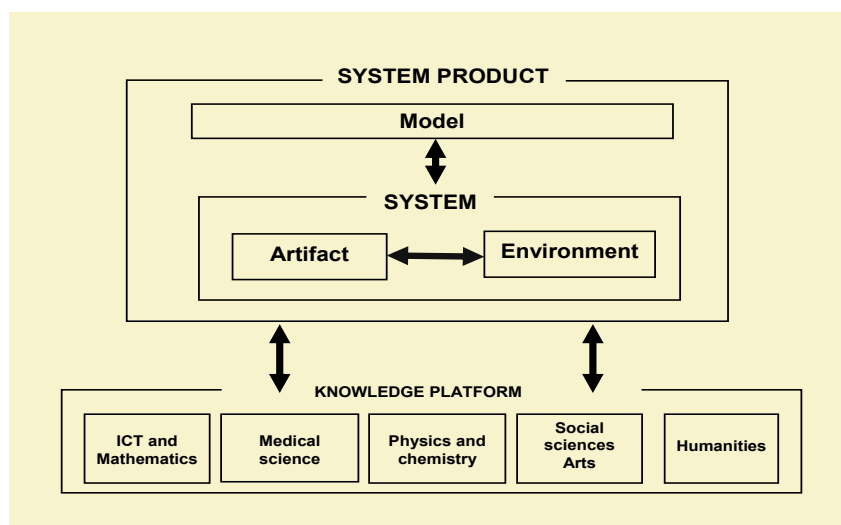
amounts of data (as is found on the Internet, through sensor-networks, economic transactions, and health data).

- Build and use self-configuring systems from "smart dust" to complex machines that operate with mission statements.
- Ensure our ability to adjust and change.

As the "Man on the Moon" challenge to the US research community shows, common objectives provide strong incentives for scientific groups. Additionally, attaining a goal highlights the quality of the knowledge upon which the concrete artefact, system and system product are built. We have selected some areas where we believe we might benefit from the synergistic effect of strong scientific cooperation. Some of the most difficult challenges we face are getting information from research on artefacts, systems and system products to feed back into generic knowledge in the basic research community. But we see that building trust across traditional borders through long-term cooperation leads to a win-win situation for everyone involved.

## Selected challenges

As of September 2006, Trondheim became one of Europe's first Wireless cities – and a real-time laboratory for developing services and technologies in an environment where people are connected everywhere and all the time through high-speed WLAN, living in an enlarged information space. The Wireless Trondheim Living Lab (WTLL) was established as a member of ENoLL, European Network of Living Labs in 2008, making NTNU become a founding member of the ENoLL AISBL organisation in January 2010. Wireless Trondheim is a research and development effort made possible through the shared efforts of the NTNU, the city of Trondheim, the Sør-Trøndelag County Council and the region's major bank, newspaper and energy suppliers (respectively SpareBank1 Midt-Norge,



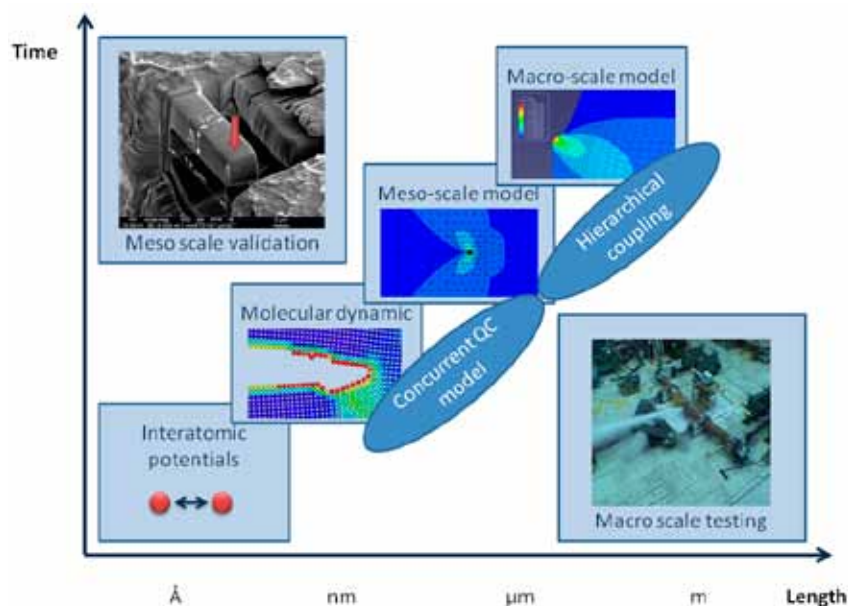
Models and products.

Adresseavisen and Trondheim Energi-  
verk). For students and Trondheim  
residents, Wireless Trondheim means  
geographically-extended and high-  
speed wireless access to the Internet.  
One quarter of Trondheim's inhabitants  
have free access to the network, and it  
is available for a limited fee for other  
inhabitants and visitors. NTNU has  
also installed full wireless coverage for  
students and staff on the university's  
campus. The municipality similarly  
provides coverage in its buildings  
(including schools).

By being member of the wider network  
of ENoLL, we aim to

- Extend and improve the development  
of own services through increased  
influx of ideas and resources (by  
involving users and industry, in par-  
ticular students and school children,  
and also from other living labs)
- Better exploit the possibilities of the  
network by enabling also others such  
as other ENoLL-members to use the  
facilities for testing out new services  
and technology.
- Increase the research activities, both  
nationally and internationally in the  
field, and by this be able to extend  
the lab and to cooperate with other  
research partners including existing  
and future living labs in ENoLL
- Anchoring the Wireless Trondheim  
initiative locally and extend coopera-  
tion between the involved parties.

The Wireless Trondheim Living Lab  
looks at a number of application areas  
including intelligent transport systems,  
energy systems and health care. Few  
application areas of ICT are as complex  
as health information services. St. Olav  
University Hospital is another "Living  
Laboratory" for defining user require-  
ments for security, reliability, privacy,  
human-machine interaction, organisa-  
tional challenges, and infrastructure  
for managing of health information.  
Our programme in health informatics  
also has at its disposal more traditional  
laboratory facilities; thus, work at the  
hospital and in the lab focuses on real  
discrepancies and opportunities. In  
serving the needs of the health services



Multiscale modeling of materials.

community, we gain generic knowledge  
that benefits other application areas as  
well. The National Centre for Electronic  
Patient Journals (EPJ) has been located  
at NTNU ceratinly in recognition of the  
university's expertise in health infor-  
matics.

Monday November 30, 2009 was the  
official opening of the new High Per-  
formance Computing (HPC) Centre at  
NTNU. It consists of an extension of  
the existing machines, now with a peak  
performance of 21 Tflops or three times  
the performance of the machine previ-  
ously operated by NTNU. The machine  
is being used by scientists from all  
over Norway, and in particular by the  
Meteorological Institute for operational  
weather forecasting. The machine has  
been financed in part by NTNU and in  
part by the Research Council of Norway  
through UNINETT Sigma. The 30 million  
NOK investment, which includes new  
cooling and housing facilities for the  
computer, was made in accordance with  
our basic ICT strategy of using enab-  
ling technologies for simulations and  
visualisations in advanced research.  
Next generation computing facilities  
are to be procured already during 2011  
in cooperation with the Meteorological  
Institute. As for research, one area  
in particular is trying to address new  
issues relative to multi scale modelling,

in the initiative with SINTEF to establish  
the CSE-Centre for Computational  
Science and Engineering.

### Externally financed research projects

The Research Council of Norway  
has established National Centres  
of Excellence (CoE) and Centres of  
Research-based Innovation (SFI) across  
the country; ICT at NTNU is involved in  
several. The two National Centres of  
Excellence that involve NTNU ICT are:

- The Centre for Quantifiable Quality of  
Service in Communication Systems  
(Q2S) is at the core of ICT. Q2S  
studies principles, derives mecha-  
nisms, methods and technical solu-  
tions, and assesses their properties  
and performances by means of ex-  
periments and models. Performance  
relates to the perceived quality of  
streamed speech/music and video,  
delays and throughput of elastic traffic  
reliability and availability of services,  
and information security with  
encryption and user authentication.
- The Centre for Ships and Ocean  
Structures (CeSOS) aims to develop  
fundamental knowledge about how  
ships and other structures behave  
in the ocean environment, using

analytical, numerical and experimental studies. This knowledge is vital, both now and in the future, for the design of safe, cost-effective and environmentally-friendly structures as well as in the planning and execution of marine operations. CeSOS is an excellent example of cooperation between cutting-edge groups including ICT, especially in engineering cybernetics.

SFIs were established in 2006 for the first time in Norway. ICT at NTNU is involved in 7 of the centres. The 3 operated by NTNU have an application focus, but are heavily dependent on ICT tools and continuing research.

- Medical Imaging Laboratory for Innovative Future Healthcare (MILab) The overall goal of the MI Lab is to facilitate cost-efficient health care and improved patient outcome through innovations in medical imaging, and to exploit these innovations to create industrial enterprises in Norway. Companies that have developed cooperation with NTNU, such as GE Vingmed Ultrasound, Microsoft FAST and Mison, are among the MI Lab's partners.
- Structural Impact Laboratory (SIMlab)

works on developing methods and tools for the virtual product development of structures exposed to impact and collisions. Having mapped the tasks that must be solved to achieve ground-breaking research within the strategically important areas of safety, the environment, economy, and structural reliability, the lab's long-range goal is to further develop related technology.

- Centre for Integrated Operations in the Petroleum Industry (CIO) conducts research, innovation and education in the IO field to promote accelerated production, increased oil recovery, reduced operating costs and enhanced safety and environmental standards. ICT is a key instrument in reservoir and production simulations as well as in various aspects of operations.
- Centre for Research-based Innovation in Aquaculture Technology (CREATE) was designed to address future aquaculture production; SINTEF Fisheries and Aquaculture is the coordinator.
- Information Access Disruptions (iAD) is being operated by Microsoft FAST ASA, FAST being a spin-off from

NTNU ICT research that was acquired by Microsoft in 2008. The objective of iAD is to develop next generation search engines that can extract user-friendly information from huge information resources.

- Statistics for Innovation is a center to make modern statistics into a better tool for developing services and products in areas such as finance, biotechnology and petroleum. It is being operated by the Norwegian Computing Center.
- The Norwegian Manufacturing Future (Norman) or SFI Norman, is an eight year research programme with the vision to develop new and multi-disciplinary research on next-generation manufacturing, as well as to create theories, methods, models, and management tools that enable Norwegian manufacturers to thrive in global competition.

### Strengthening relations at European level

One of ICT's major strategies has been to expand cooperation with the European research community. NTNU is the

### Major ongoing research projects that have been awarded funding by the Research Council of Norway (directly or through Nordic financing) are:

- Snake Locomotion in Challenging Environments, Kristin Y. Pettersen
- eGenVar – Handling, integrating, and analysing biobank data in a hypothesis-driven framework, Pål Sætrum
- SmartIES – Smart Individual Energy Savers, John Krogstie
- Optimal Power Network Design and Operation, Tor Arne Johansen
- IO Compliant robotized facilities, NTNU/ABB, Charlotte Skourup
- SMIDA – Smart Microsystems for Diagnostic Imaging in Medicine, Trond Ytterdal
- Computational Methods in Non-linear Motion Control, Tor Arne Johansen
- Evicare – Evidence-based care processes: Integrating knowledge in clinical information, Øystein Nytrø
- Hercules, Øystein Nytrø
- CROPS – Cross-layer optimization of wireless sensor networks, Geir Egil Øien
- SPAM - Statistical Physics in Advanced Multi-user Communications, Ralf Reiner Muller
- HEXAnord, HEalth teXt Analysis network in the Nordic and Baltic countries, Øystein Nytrø
- Enhanced Model Predictive Control, Morten Hovd
- Technical platform for wireless biomedical sensor network, Ilanko Balasingham
- SIRKUS - Spoken Information Retrieval by Knowledge Utilization in Statistical Speech Processing, Torbjørn Svendsen
- FABULA – Seamless networks for transforming the city into an arena for learning, Monica Divitini
- IS\_A – Integrated Semantic Access in Situated Operations, Jon Atle Gulla
- Fabrication of tunable mid-IR laser diodes for sensor and communication application, Bjørn-Ove Fimland
- DASCOSA – Database Support for Computational Science Applications, Kjetil Nørvåg
- FIPP – Flexible Integration Processes in the Public Sector, Eric Monteiro
- Regional communication within and

Norwegian member of ERCIM (European Research Consortium for Informatics and Mathematics), EURECOM, and ENoLL AISBL as mentioned previously. In addition to facilitating cooperation with other members, ERCIM is also a facilitator for involvement in European Union projects.

NTNU participated in a number of projects under EU's 6 Framework Programme (FP). So far we are involved in the following projects under the EU's FP7.

- SENDORA - SENSor Network for Dynamic and Opportunistic Radios Access, Torbjørn Ekman
- EURO-NF - Anticipating the network of the future - from theory to design, Svein Johan Knapkog
- PRESEMT - Pattern REcognition-based Statistically Enhanced MT, Bjørn Gambäck
- ABCDE - Alain Bensoussan Career Development Enhancer, Tore R. Jørgensen
- MIRROR - Reflective Learning at Work, Monica Divitini
- CESAR - Cost-Efficient methods and processes for Safety Relevant

embedded systems, Tor Stålhane

- TARGET - Leif Martin Hokstad
- Travel in Europe - Ekatarina Prasolova-Førland
- HIPEAC - High Performance and Embedded Architecture and Compilation, Lasse Natvig
- FreesubNet - Marie Curie RTN on Intervention-Autonomous Underwater Vehicles, Kristin Y. Pettersen
- CLARIN - Common Language Resources and Technology Infrastructure, Torbjørn Svendsen.
- Statistical Challenges on the 1000€ Genome Sequences in Plants, Finn Drabløs
- SIMOLA - Situated Mobile Language Learning, Sobah Abbas Petersen

## Innovation and dissemination

In addition to research and teaching activities, a number of activities are related to innovation and dissemination of research results to a broader audience. ENoLL has been mentioned earlier, other important initiatives are ITovation and NOKIOS.

ITovation is a series of seminars for PhD-students, researchers and students focus on innovation, creativity and improvisation applying ICT.

ITovation seminars can combine:

- Speeches by industry experts on innovation
- Presentation of innovative PhD-projects at NTNU
- Improvisation through music
- Electronic art performance
- Creative food and drinks
- Networking
- Online streaming

Find out more at [www.itovation.org](http://www.itovation.org)



NOKIOS: The Norwegian Conference on eGovernment is arranged yearly in Trondheim by the research programme on ICT in the Public



Sector. The target groups for the event are decision makers from the Norwegian public sector, politicians, managers, project leaders, IT professionals, researchers, and other stakeholders working in and on the public sector and vendors. The aim of the conference is

across health organisations, Eric Monteiro

- NanoLaser, Helge Weman
- SQC- Security of quantum cryptosystems, Johannes Skaar
- Quevirco - Quality of Experience in Virtual Collaboration, Peter Svensson
- SMUDI - Voice Control in Multimedia Dialogue, Torbjørn Svendsen
- WILATI+ Wireless interference-Limited high-throughput Access Technologies and applications, Nils Torbjörn Ekman
- LongRec - Long-Term Records Management, Kjetil Nørvåg
- COMIDOR - Cooperative Mining of Independent Document Repositories, Kjetil Nørvåg

- ReqSec.- Requirements for Secure Information Systems, Guttorm Sindre
- SAMPOS - Strategies For Seamless Deployment Of Mobile Patient Monitoring Systems, Ilangko Balasingham
- COSTT - CoOperation Support Through Transparency, Pieter Jelle Toussaint
- UbiCompForAll - Ubiquitous service composition for all users, Rolv Bræk
- MELODY - Medical Sensing, Localization, and Communication using Ultra Wideband Technology, Ilangko Balasingham
- Integrated Marine Electrical Power Control Systems, Lars Einar Norum

- Control, Information and Communication Systems for Environmental and Safety Critical Systems, Kristin Y. Pettersen
- GoICT - Dependable ICT for the Energy Sector, Torbjørn Skramstad
- Wind energy conversion using high frequency transformation and DC collection, Hans Kristian Høidalen
- Next Generation Robotics, Kristin Y. Pettersen
- GHeI - Global e-health, Eric Monteiro
- BIP Jupiter Robotics NTNU/ABB, Jan Tommy Gravdahl
- Multimodal Myoelectric Unit (MMU): Sensor for external prostheses, Øyvind Stavadahl

to create a meeting place for a broad range of employees and politicians, researchers and other stakeholders in the public sector (including vendors) where attendees can meet other stakeholders who may share your research and job interests or concerns.

**Find out more:** [www.nokios.no](http://www.nokios.no)

## Research programmes

From its inception in 2003, the ICT strategic area has established a number of interdisciplinary research programmes. What follows is a description of the scope of the current eight programmes, along with key researchers associated with each programme.

### BIOINFORMATICS

The programme for bioinformatics consists of interdisciplinary cooperation between research groups in medicine, biology and informatics from the Faculty of Medicine (DMF), the Faculty of Natural Sciences and Technology (NT), and the Faculty of Information Technology, Mathematics and Electrical Engineering (IME) at NTNU.

Bioinformatics is a discipline at the interface of molecular biology and informatics. The field is a prerequisite for newer areas of research in molecular biology, such as genome research, ultra-high throughput sequencing, proteomics and studies of relationship between gene variation and disease. Research in bioinformatics also involves development of novel methods for data analysis, using methods from computer science, mathematics and statistics.

Much of the bioinformatics research at NTNU is associated with FUGE II, phase 2 of the national plan for functional genomics. Several other FUGE projects are linked to bioinformatics, including projects in proteomics, biobanks, genome sequencing, microarray analysis and structure biology. Future work will relate to the new programme BIOTEK 2012. There are also strong links between bioinformatics and research on systems biology at NTNU.

Director: Professor Finn Drabløs,  
Department of Cancer Research and  
Molecular Medicine  
Coordinator: Adviser Janne Østvang,  
Faculty of Natural Sciences and  
Technology

Programme Committee:

- Professor Kjell Bratbergsengen, Department of Computer and Information Science (committee leader)
- Professor Catharina Davies, Department of Physics
- Professor Atle Bones, Department of Biology
- Professor Eivind Almaas, Department of Biotechnology
- Associate Professor Mette Langaas, Department of Mathematical Sciences
- Professor Pål Sætrum, Department of Computer and Information Science
- Post doc Waclaw Kusnierczyk, Department of Computer and Information Science

### HEALTH INFORMATICS (NSEP)

Medicine and ICT Health informatics aim to strengthen existing research and to establish new research and education within health informatics at NTNU. This is achieved by coordinating

and stimulating activities, taking an interdisciplinary and broad approach, and employing technology and problem expertise in health informatics research in the many environments of NTNU, SINTEF, Central Norway Regional Health Authority, KITH (Norwegian Centre for Informatics in Health and Social Care), the Norwegian Patient Register, St. Olavs Hospital Trust, HEMIT (Regional Health IT-service), and industry.

The Research Council of Norway earlier established a national R&D centre for electronic patient records at NTNU (NSEP – the EPJ centre). Electronic patient records are one of the biggest challenges the health sector faces in terms of the development and use of ICT. The EPJ centre was awarded an annual grant of NOK five million per year over five years. A further funding of 3 million NOK per year for 2010–2011 has been allocated by the health sector. In addition, a large portfolio of projects are funded by the Norwegian Research Council, as well as by international sources.

Director: Associate Professor Arild Faxvaag, Faculty of Medicine  
Co-director: Professor Pieter Jelle Toussaint Faculty of Information Technology, Mathematics and Electrical Engineering  
Coordinator: Trond Stillaug Johansen, Faculty of Medicine

Council

- Herlof Nilssen, Helse Vest (chair)
- Berit Brattheim, Høgskolen i Sør-Trøndelag (HIST)
- Finn Drabløs, Faculty of Medicine
- John Krogstie, Faculty of Information Technology, Mathematics and Electrical Engineering
- Aksel Tjora, Faculty of Social Science and Technology Management

### LEARNING WITH ICT (LIKT)

The research area is inherently interdisciplinary and represents a meeting place between a variety of scientific areas, ranging from ICT to the social sciences, where pedagogic and didactic



Photo: Erik A. Drabløs

traditions are of particular relevance. The focus on mobile and ubiquitous learning, collaborative learning environments, learning at work, and 3D learning environments. ICT is increasingly intertwined in learning processes in industry and education. A generation of learners to whom ICT is a part of their social and cognitive fabric is soon moving into higher education. ICT provides new means to organise, develop and utilize resources inside organisations and educational institutions. Tomorrow's society will be even more influenced by digital and net-based technologies. LIKT has through its projects conducted research that point to transverse traits of development that can give new insight into the complex relationship between learning and technology.

LIKT takes part in a research programme financed by the Research Council of Norway FABULA, that involves three different departments. The programme also takes part in research projects under EU FP7, including TARGET, MIRROR and SIMOLA. TARGET involves collaboration with SINTEF, international industry partners (Nokia and Siemens) and major international technical universities. Together with IDI and UBIT, LIKT is building a Virtual Campus of NTNU to serve as an arena for educational activities and as a resource for students and teachers of NTNU. LIKT has also been involved in an EU project Travel in Europe, which resulted in the virtual reconstruction of the most prominent buildings in Trondheim. At the moment LIKT participates in "Eidsvoll 1814" project together with Globalskolen and the National Centre for ICT in Education.

Director: Associate Professor  
Leif M. Hokstad  
Coordinator: Ekatarina Prasolova-  
Førland SVT and IDI, NTNU

#### LANGUAGE TECHNOLOGY

The Programme for Language Technology (LT) is an interdisciplinary unit with participants from the Faculty of Arts and the Faculty of Information



Technology, Mathematics and Electrical Engineering. The LT programme coordinates and initiates language technology activities connected to NTNU. The main external partners are IBM, SINTEF and Telenor.

Language technology is about getting machines to "understand" a natural language like Norwegian, and behave as if they are proficient in that language.

The language technology programme at NTNU mainly encompasses:

- Speech technology (speech recognition, speech synthesis, automatic dictation)
- Question systems based on natural language
- Linguistic dialogues between human and machine
- Machine-based translation
- Meaning-based information retrieval
- Automatic sentence analysis and production
- Development of machine-readable dictionaries for use in language technology

Director: Professor Jacques Koreman,  
Department of Language and  
Communication Studies (NTNU)  
Administrative coordinator:  
Mehdi Soufifar

Programme Committee

- Professor Torbjørn Svendsen, leader,  
Department of Electronics and Tele-  
communications (Committee leader)
- Professor Björn Gambäck,  
Department of Computer and  
Information Science
- Professor Lars Hellan, Department  
of Language and Communication  
Studies

- Dr. Torbjørn Nordgård, Lingt
- Dr. Erik Harborg, SINTEF

#### COMPUTATIONAL SCIENCE AND VISUALISATION

The programme has been charged with meeting national HPC and visualisation needs, both for basic research and in industrial development. The programme's projects are designed to promote and develop special expertise in the fields of HPC and visualisation with a base in NTNU's core areas, to provide access to adequate, dependable, and cost effective computing power for users at NTNU and in other national institutions, and to educate researchers whose expertise lies in computation science.

A number of research areas at NTNU demand high performance computing, including reservoir simulations, seismology, marine technology, molecular dynamics, chemical process technology, structural engineering, materials technology, bioinformatics, and medical visualisation and diagnostics. What all these areas share in common is that they typically involve interdisciplinary activities, such as physical modelling, mathematical analysis, numerical analysis, and algorithm development, resource demanding calculations, visualisations, and securing quality in the simulation results.

Directors

- Associate Professor Jørn Amundsen,  
Co-Director (Director - Infrastructure)
- Professor Einar Rønquits, Co-Director  
(Director - Numerical Methods)

Programme Committee:

- Professor Syvert Nørsett, Department of Mathematical Sciences
- Professor Lasse Natvig, Department of Computer and Information Science
- Professor Hugo A. Jakobsen, Department of Chemical Engineering
- Professor Per-Olof Åstrand, Department of Chemistry
- Professor Helge Andersson, Faculty of Engineering Science and Technology
- Associate Professor Trond Kvamsdal, Department of mathematical sciences
- Bjørn Lindi, NTNU IT

## ICT IN THE PUBLIC SECTOR

The eGovernment programme at NTNU aims to strengthen existing research and to establish new research and education within ICT in the public sector. This is achieved by coordinating and stimulating interdisciplinary research and activities using a broad approach, and by building technological expertise and problem-solving approaches in eGovernment research at NTNU, and in public and commercial enterprises. The programme is focused on areas anchored in the St.Meld nr.17: Eit informasjonssamfunn for alle the EU Ministerial declaration on eGovernment from November 2009, and the Digital Agenda for Europe from 2010, specifically regarding ICT relevance relative to the following areas:

- A democratic knowledge society that ensures participation possibilities for all
- Simpler cooperation between citizens, businesses and the public sector
- A more appropriately governed society
- Effective and efficient development, evolution and maintenance of public IT-solutions
- Methods for implementation of ICT solutions in the public sector

The programme cooperates closely with the programmes in health informatics and learning with ICT.

Director: Professor John Krogstie, Department of Computer and Information Science

Programme committee:

- Professor Arne Krokan, Department of Sociology and Political Science (Committee leader)
- Associate Professor Øystein Nytrø, Department of Computer and Information Science
- Jens Nørve, Direktorat for forvaltning og IKT (DIFI)
- Professor Jan Tøssebro, Department of Social Work and Health Science

## COMPUTER GAMES

The programme complements the country's existing higher education offers in computer game design and technology, and has as main objectives to coordinate and stimulate new research on various aspects of computer games, both within the university itself and among the half-dozen universities and university colleges that offer computer-game related studies. In addition, the programme works to strengthen the link between the industry and academia with a focus on innovation of computer games. JoinGame, Norway's largest professional network on game research and game development was funded by NTNU's research programme on Computer Games in 2007, which now consists of over 150 member organisations where more than 85 represents companies in Norway and abroad. Through the establishment of JoinGame, NTNU's education and research on computer games is widely known and respected.

Currently, eight PhD candidates are working within the programme covering both the technical part of game development as well as studying the game players and the games themselves. In addition to the PhD candidates, around 30 master students work on projects related to computer games yearly. Research topics covered by this programme are user studies of multiplayer games, development of technology, models and architecture of pervasive games, learning games and mobile games, design and development of new game technology, media protocols and tools for serious

gaming, computer graphics, artificial intelligence in games, etc. The programme has established collaboration with international universities like the University of California, Irvine. Last year, two labs on computer games have been established at NTNU. Since the start of the programme, five courses related to computer games have been established.

Director: Associate Professor Alf Inge Wang, Department of Computer and Information Science

Programme Committee:

- Associate Professor Sara Brinch, Department of Art and Media Science (leader)
- Associate Professor Harald Øverby, Department of Telematics
- Associate Professor Trond Are Øritsland, Department of Product Design
- Associate Professor Berit Skog, Department of Sociology and Political Science
- Tor Ivar Eikaas, Cyberlab (industry)
- Erik Harg, TerraVision (industry)

## ROBOTICS

The programme for Robotics addresses the Norwegian industry and society's needs for know-how and international high quality research in advanced robotics. The programme aims to strengthen existing research and further facilitate the interdisciplinary cooperation between research groups for both development and application of advanced robotics solutions.



Robotics is an enabling technology for a multitude of applications important for both industry and the society at large. International trends and the Strategic Research Agenda for Europe show for instance that in order to be competitive, Norwegian factories should be equipped with robots introducing (semi)-automation in various operational cycles. Robots can substitute high-cost labour in dull, dirty and dangerous environments and contribute to the reduction of production costs as well as to growth in a global market. It is therefore a main priority to bring advances of robotics technologies into Norwegian industry and society. The Programme for Robotics will initially focus on the following research topics

- Next generation industrial robotics
- Marine robotics
- Autonomous robots/Unmanned vehicles
- Nano-robotics

- Robotics in Medicine and Healthcare
- Snake robotics/robotic mobility in unknown and challenging environments

Director: Professor Kristin Y. Pettersen, Department of Engineering Cybernetics, NTNU

Programme Committee

- Professor Asgeir Sørensen, Department of Marine Technology (Leader)
- Professor Terje K. Lien, Department of Production and Quality Engineering
- Professor Thomas Tybell, Department of Electronics and Telecommunications
- Associate Professor Ronald Mårvik, Department of Cancer Research and Molecular Medicine
- Senior Researcher Ingrid Schjølberg, SINTEF ICT
- Technology Manager Christoffer Apneseth, Robotics Products, ABB

### ICT Basics at the Faculty of Information Technology, Mathematics and Electrical Engineering

The knowledge platform at the Faculty of Information Technology, Mathematics and Electrical Engineering at the departments (research groups) consists of:

- Engineering Cybernetics (Motion control, Process control, Instrumentation and industrial control systems)
- Electronics and Telecommunications (Acoustics, Circuits and systems, Electronic devices and materials, Electrooptics, Radio systems, Signal processing)
- Telematics (Information security, Networks, Networked systems)
- Computer and Information Science (Algorithm construction and visualisation, Computer architecture and design, Database systems, Information management, Software engineering, Human-computer interaction, Information systems, Artificial intelligence and learning, Image processing, Knowledge systems)

We feel confident that our level of expertise in basic ICT is satisfactory. The numerous acquisitions of ICT start-ups in Trondheim by multinationals (like ARM, Microsoft, Yahoo, Oracle, Atmel and Weatherford), demonstrate just that. The positive development of Norwegian owned companies like Qfree, FunCom and Telenor and a number of new start-ups like New Index, Mison, Interagon, Wireless Trondheim, Verdande and Secustream are an additional proof. However, the limited number of people involved in basic ICT research restricts development, and does not allow us to fully accommodate all the requests for expertise needed in the various sectors.

### Leader group

- Leader Strategic Area ICT, Vice-Dean John Krogstie, Faculty of Information Technology, Mathematics and Electrical Engineering
- Sara Brinch, Faculty of Humanities, Programme committee leader "Computer Games"
- Arne Krokan, Faculty of Social Science and Technology Management, Programme committee leader "eGovernment"
- Kristin Ytterstad Pettersen, Faculty of Information Technology, Mathematics and Electrical Engineering, Programme committee leader "Robotics"
- Arild Faxvaag, Faculty of Medicine, Programme committee leader "Health Informatics (NSEP)"
- Arne Bredesen, Faculty of Engineering Science and Technology, leader of the strategic area Energy and Petroleum – Resources and Environment
- Tore Jørgensen, Faculty of Information Technology, Mathematics and Electrical Engineering, Coordinator

### Council

- Lead by the Dean of Faculty of Information Technology, Mathematics and Electrical Engineering at NTNU, Geir Øien
- Ingvild Myhre, Rådgiverne LOS
- Gunn Ovesen, Director Innovation Norway
- Eirik Næss-Ulseth, Administrating director, PubGene
- Dagfinn Myhre, R&D director Telenor
- Anne Persson, Professor at the University of Skövde, Sweden
- Andreas Opdahl, Professor at the University of Bergen
- Ole Ivar Sivertsen, Professor at the Faculty of Engineering Science and Technology, NTNU
- Jan Morten Dyrstad, Dean at the Faculty of Social Science and Technology Management, NTNU
- Stig Slørdahl, Dean at the Faculty of Medicine, NTNU



**NTNU – Trondheim**  
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**NTNU – The Norwegian University of Science and Technology.**

The Norwegian University of Science and Technology (NTNU) in Trondheim represents academic eminence in technology and the natural sciences as well as in other academic disciplines ranging from the social sciences, the arts, medicine, architecture and the fine arts. Cross-disciplinary cooperation results in ideas no one else has thought of, and creative solutions that change our daily lives.

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