



2008-2015

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Estonian Center of Excellence in Computer Science

EXCS - the Estonian Center of Excellence in Computing, is one of the seven national centers of excellence (CoEs) of Estonia 2008-2015, projects within a measure of the Estonian system for implementing the EU Structural Funds 2007-2013.

It unites computer scientists from three institutions - the Institute of Cybernetics at Tallinn University of Technology, Cybernetica AS and the University of Tartu and encompasses most of the computer science research conducted in Estonia.

The general objective of the center is to consolidate and advance the Estonian computer science in six areas of recognized strength.

The specific objectives are:

- ✓ to boost the research potential of the groups involved by facilitating collaboration and safeguarding their sustainability and growth
- ✓ to increase the impact of their research results in academia, industry and society, as well as to popularize them.

These will be achieved by carefully planned coordination and joint actions, aimed at creating a thriving, highly reputed research environment, attractive for young researchers, in particular from abroad.

The research activity is organized into working groups (WGs) crossing institution boundaries.

The priority joint support actions are: attraction to Estonia of international postdocs, organization of high-level international scientific conferences and schools, technology transfer actions, popularization of computer science among the general public, especially schoolchildren, on the domestic scale.

As of 1 March 2009, EXCS involved 54 senior staff and 56 PhD students. Distinctively for the Estonian research landscape, the center is led by young researchers.

The budgeted structural assistance to EXCS over the whole duration of the project is 4.25 MEUR; the Estonian state has contributed an additional grant of 0.25 MEUR and compensates the ineligible VAT.

EXCS capitalizes on the experience and achievements of the predecessor national CoE project, the Center for Dependable Computing (CDC, 2002-2007).

WORKING GROUPS

Programming languages and systems (PLS)

The WG develops programming language based technology for ensuring software correctness and safety, covering both methods and tools for analysis, verification and certification of code written in programming languages that are the current industrial standard as well as design and implementation of novel programming languages with built-in mechanisms for enforcing such properties. The areas of expertise and research activity cover type systems and program logics, program analysis and transformations, functional and dependently-typed programming, categorical semantics, automata and context-dependent computing.

The WG took part in the EU FP6 IST coordination action TYPES on type-theoretic reasoning and programming and is contributing to the EU FP6 IST integrated project MOBIUS on proof-carrying code and COST action IC0701 on verification of object-oriented software. It hosted the language-based software technology conferences ICFP/GPCE 2005 and MPC/AMAST 2006.

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Information security and cryptology (Sec)

The WG develops methods and tools for secure two-party and multiparty computation, cryptographic protocol analysis, and risk analysis of systems based on attack trees. It also researches the limits of the proof methods used in cryptography. The WG has designed and implemented one of the most efficient frameworks for secure multiparty computation, as well as tools for sound analysis of protocols and for the construction and analysis of multi-parameter attack trees. It also has extensive experience in public-key infrastructures, especially time-stamping, and in privacy-preserving data mining.

The WG is contributing to the EU FP6 IST STREP BalticTime, integrated project AEOLUS and FP7 IST STREP VirtualLife. It has tight connections to the developers of the electronic infrastructure of Estonia.

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INSTITUTIONS



The **Institute of Cybernetics** (IoC), founded 1960, as an Estonian Academy of Sciences research institute, is today a semi-autonomous research institute of the Tallinn University of Technology (TUT). With its research fields in control science, mechanics, applied mathematics and computer science, the institute is highly interdisciplinary. TUT, established 1918, is the sole engineering university of Estonia and the largest university of Tallinn. In particular, TUT is also Estonia's main provider of university-level education in ICT.



Cybernetica AS, started in 1997, is a private R&D company specializing in information security products, enterprise software solutions, visual navigation and signalling components. It is particularly well known for its contributions to the digital signature and e-elections systems of Estonia.



The **University of Tartu** (UT) is the classical university of the small nation and also the largest university. Apart from the computer science department of the Faculty of Mathematics and Computer Science, EXCS also engages researchers from the department of Estonian and general linguistics, thus building on both the mathematical and linguistic excellence of the institution, but also benefitting from the proximity of, for example, biologists.

Software engineering (SE)

The WG conducts research around the following question: How to build and maintain integrated software systems that are aligned with business operations? It focuses on three approaches to this question:

- ✓ business process management: analyzing and building software systems based on models capturing how an organisation works, also called business process models;
- ✓ service-oriented computing: analyzing and building software systems based on the metaphor of "software as a service", usually on top of Web technology;
- ✓ semantic technology: capturing metadata about information and software resources in order to guide the construction of interoperable information and software systems.

Specific research topics that the WP currently works on include: information retrieval in process model repositories; matching and merging business process models; measuring compliance between business process models and business operations; measuring and improving the maintainability and interoperability of service-oriented software systems; semantic annotation and analysis of repositories of web service descriptions.

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Scientific and engineering computing (Comp)

The WG performs research in the areas of scientific and engineering computing, parallel, grid and cloud computing, developing a parallel solver DOUG of large systems of linear equations and a visual intelligent modelling and simulation tool CoCoViLa.

One new product of the WG is the lightweight desktop grid middleware, the Friend-to-Friend Computing framework, which cross-connects Instant Messaging clients to form a spontaneous high-performance computing environment.

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Bioinformatics (BI)

The bioinformatics WG deals with various aspects of biological data analysis with the general goal to advance our understanding of living systems. To this end new methods and tools are needed, as well as tools that can help biologists manage, query and analyse the vast and ever-increasing amounts of biological experimental data. Overall, bioinformatics is a rapidly developing multi-disciplinary field that is gaining increasingly more contact points with different corners of computer science and computational disciplines. Areas as diverse as algorithm design, machine learning, statistics, natural language processing and scientific literature mining, pattern matching, database development, software engineering, visualisation, and even secure privacy-preserving data management and mining techniques become relevant for processing biological data.

The WG works on gene expression and other high-throughput data analysis, network reconstructions for systems biology, data mining and visualisation methods and tools, as well as clinical trial data management and biomarker discovery. It participated or is currently taking part in the EU FP6 LifeSciHealth integrated project FunGenES, network of excellence ENFIN, STREPs ATD and COBRED and FP7 HEALTH integrated project ESNATS.

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Language technology (LT)

The WG develops rule-based and statistical models of the morphology, syntax, semantics and pragmatics of the Estonian language and text, transcribed speech and dialogue corpora. It also studies the Estonian sound system and prosody, building speech synthesis and recognitions tools for Estonian and corpora of recorded speech.

These studies of the Estonian language are unique and indispensable for achieving the high goals of the Strategy of development of the Estonian Language that the WG is currently working towards in the National Programme for Estonian Language Technology (EKKTT).

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