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A pro-active canvassing strategy and the realisation that industrial collaborations and fundamental research are interdependent have turned CISS into a renowned and recognized international brand CISS: RESEARCH AND BUSINESS

It started out as a governmentally-funded project in 2002, but today, Centre for Embedded Software Systems, CISS, has long since proven their ability to stand on their own feet. The centre functions as an independent unit anchored in the Department of Computer Science and the Department of Electronic Systems at Aalborg University. And this special independent status means that the centre performs both research and business.

"Our primary task is to establish connections between industry and research, and we are engaged in several industrial collaborations both regionally and nationally. We make a point of canvassing - of visiting companies and introducing ourselves, and that has proven a good way of opening doors to enterprises that do not otherwise have a tradition for considering the university as a potential partner in their development work," director of CISS, professor Kim Guldstrand Larsen explains.

EDUCATING BRIGHT NEW MINDS

"We also perform fundamental research, but to us in CISS, there is a clear connection between fundamental research and the ndustry-oriented projects. One cannot exist without the other," Kim Guldstrand Larsen points out and continues:

"CISS is a business - our main goal is creating tan-

gible results for our industrial partners. Consequently, we work at a very advanced academic level, and we need to uphold that to keep our status as an attractive collaborator. The fundamental research performed in projects such as MT-LAB (see page 18) contributes to our staying acute, and at the same time we secure the food chain by educating new Master and PhD students. Furthermore we manage the elite-level education in embedded software, and hope to be able to offer an international MA in embedded software here at CISS very soon."

In addition, CISS is at the front line both nationally and internationally when new solutions within embedded software are developed. On the following pages, you can read about CISS' participation in a wide range of research projects and in initiatives supporting European research and development within the field (see page 14), and about how CISS is also an active contributor when embedded software is placed within larger strategic contexts such as regional development in North Denmark or IT innovation on a national scale. Thus, CISS heads the national Danish innovation network InfinIT (see page 12) and is also one of the key players in the BrainsBusiness – ICT North Denmark initiative (see page 16).



Director of CISS Kim Guldstrand Larsen is looking forward to new academic and strategic collaborations – regionally, nationally and internationally.



The so-called knowledge voucher, which has been developed by the Danish Agency for Science Technology and Innovation, grants small and medium-sized enterprises a subsidy for buying knowledge from a knowledge institution. The arrangement can be used by companies that have not collaborated with a knowledge institution within the last three years, and the purpose is to increase the number of collaborations between this kind of enterprise and Danish research institutions – and thus the amount of knowledge exchange and dissemination going on.

The enterprise gets the opportunity to purchase the help of one or more researchers in the course of a development project and will receive knowledge corresponding to the value of the knowledge voucher, that is, between DKK 50,000 and 100,000, depending on what the enterprise needs.

GETS VOUCHER FOR NEW KNOWLEDGE

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The wireless-communication manufacturer DANPHONE has saved valuable time by making use of the special knowledge voucher system which gives companies financial subsidies for the purchase of knowledge from university minds

When British engine drivers communicate with each other, they use radio communication. And the equipment they use comes from the company DANPHONE, located in North Denmark. The company also helps ensure that it is possible to communicate with vessels at sea though coastal radio – they are responsible for the shore-based part of the communication. But DANPHONE, which has existed since 1990, and whose clients include companies and authorities all over the world, was facing a number of technological challenges at the end of 2008. And help happened to appear from an unexpected party - that is, from CISS, who were practically unknown to the company. And who could even offer DANPHONE a substantial discount on access to the centre's specialists, thanks to the so-called knowledge voucher.

INVITED THEMSELVES IN

"The local business support office had invited us to a post-workday meeting where CISS did a presentation. I had heard of CISS before, but I honestly thought they were some sort of educational center. It soon became obvious that they were something quite different – and then they asked whether they could come visit us. And of course we said yes," technical director Jens Lucassen, DANPHONE, says.

Along with business consultant Søren Westergaard from the local business support centre, a couple of representatives from CISS visited the company, and that was the beginning of a productive collaboration between the company and researchers from CISS.

"When you build systems as extensive as ours, in which everything is controlled by computers, they cannot be allowed to "crash." The people from CISS collaborated with our engineers on finding a method of achieving redundancy, that is, building a number of similar units in order to ensure that the system works in a correct and stable way," Jens Lucassen explains.

SOLVED TWO PROBLEMS

Through their analysis of DANPHONE's problem, the researchers found that there was currently no solution on the market that the company could use – in other words, they would have to develop such a system on their own. And that would take a large development effort. But CISS showed the company another solution, namely to change their operating system to a so-called open-source system that it would be easier to expand on – and thus create the necessary redundancy – than it is on Windows.



Business consultant Søren Westergaard from the local business support office and technical director Jens Lucassen, DANPHONE, are delighted that they opened the door to CISS.

"We have not solved the problem – but without the help from CISS it would have taken us a very long time to reach that conclusion. We got an answer that allows us to move on," Jens Lucassen explains and continues:

"It actually did not take that long – we still had some researcher hours left on our knowledge voucher, so we asked them to take a look at a different problem. We are in the process of developing our own voice-over-IP system for use in shore-to-ship communication. Such communication needs to work fast with no waiting for answers from the other end, the way we are used to from satellite communication. CISS worked with us on analysing how speech can reach its target with no delay, and in addition they found out how we can optimise the sound."

NOT USED TO COLLABORATING WITH AALBORG UNIVERSITY

Jens Lucassen has no doubt as to the significance of the encounter with CISS and the knowledge voucher: "It has given us great impetus. Our new products will have shorter time to market than usual, and the finished products will be of a higher quality."

This pleases Søren Westergaard, and he sees new opportunities for companies in the area. "There is no doubt that several other companies in our area would benefit from collaborating with CISS and the other departments at Aalborg University. Even though we are located only a few miles from the university, we are often seen as being in a fringe area, and most of the companies here have no tradition for collaborating with knowledge institutions. Therefore CISS must be commended for being so dynamic and outgoing. We go on company visits together, where CISS introduces their competences and the various forms of collaboration they offer – and of course the benefits the company can get," Søren Westergaard points out and continues:

"At our business support office, we are always on the look-out for chances to engender results by matching companies with researchers at the university. By and large, it is our job to keep every door open in order to find the people who will be able to help the companies in our area – and in that connection it is nice that people like CISS come knocking of their own accord."



DANPHONE is one of the world's leading manufacturers of advanced wireless communication equipment. The customer base includes SAAB, Siemens and British Rail, and the company's products are used all over the world. More than 95 % of the company's activities relate to international projects and deliveries **Read more at**

www.danphone.com

Production manager Jens Juul, aøs A/S, trusts the company will gain large cost reductions after their collaboration with CISS.

ACUTE MINDS TO REDUCE WASTAGE AT STEEL PRODUCTION PLANT



The steel production plant aøs A/S in North Denmark has made use of a knowledge voucher for collaboration with CISS and expect to reduce wastage and save money on steel bars



The steel production plant aøs A/S has 54 employees and has been experiencing rapid growth and corresponding expansion of capacity and premises over the last 10 years. The company manufactures a wide range of products for any possible enterprise within forging and machine work, and the company wishes to be the clients' preferred collaborator from idea to finished product, within industry, construction and plumbing.

Read more at www.aoes.dk



Read more about the knowledge voucher system on page 4 What do engineers and computer scientists know about steel bars? At the steel production plant aøs in a small village not far from Aalborg University, the answer is: "More than you'd think."

"We had the same problem that many other companies like ours experience: when we cut six- and twelvemeter bars of steel, we end up with a lot of useless bits. But through our local business support office, we made contact with CISS. At first I thought 'how will they be able to help us?', but then I read an article about how they solved a similar problem. We agreed that we send them a number of shortening lists, and on the basis of these lists, CISS is now in the process of making a simulation showing how we can reduce wastage. They will be finished with the programme in the near future," production manager Jens Juul, aøs A/S explains.

MAKING HOUSE CALLS

In the summer of 2009, the researchers visited the plant and tested their solution, and Jens Juul was satisfied with what he saw.

"It fully lives up to our agreement. It needed a few minor adjustments which they had to go back and make, and we plan to have the new system up and running before Christmas," Jens Juul says.

The production manager admits to large cultural differences between the world of research and a chip-removing plant like aøs, which is a supplier to MAN Diesel among others. "It is my guess that many enterprises such as ours refrain from asking the university for advise – simply because they do not know who to ask," he explains. But CISS has solved that problem: they make house calls to companies to introduce themselves, and so far this has led to an impressive series of collaborations with companies who would not normally consider the university as a potential collaborator.

"It is quite obvious that CISS' greatest strength is their will to canvass – and in addition, aøs should be commended for daring to seek new roads in the attempt to become more efficient," trade promotion officer Marianne Gade from the local development council says praisingly. She was the one who set up the meeting between CISS and aøs.

BOTTOM LINE FIGURES

"People from the university and business people do not always speak the same language, so we make sure we always go along on visits like that. But we have had great success in matching researchers with companies here in our area, and several large enterprises participate in long-term research and development projects with the university," Marianne Gade points out.

Companies which have no prior history of collaborating with the university can make use of the knowledge voucher system (see page X). And that is exactly what aøs did. "The results show on the bottom line when you collaborate with the university. If they did not, collaboration would not be desirable," Marianne Gade emphasizes, and Jens Juul agrees. "We expect to gain a significant cost reduction from this project."



The electrical contractor H. Jespersen & Søn A/S in Hirtshals on the West Coast of Denmark will soon be presenting a unique solution for home automation, thanks to the knowledge voucher system and qualified help from CISS

"You see... Some of the knowledge that CISS provided has made the road a lot shorter. It has given us a better product."

Electrician Henrik Mikkelstrup from H. Jespersen & Søn A/S is happy that the people at Hjørring Business Support Office knew exactly who the company should contact when they were facing a concrete problem.

"For a long time, we have been working on the development of our own unique solution for home automation – that is, the control of light, heat and ventilation in houses, offices, schools and other institutions. It must be a system that is both convenient and energysaving – in other words, a kind of "smart" energy control. But we ran into a problem concerning software in connection with the wireless sensors – a problem we did not seem able to solve ourselves. Therefore, we contacted the local business support office," Henrik Mikkelstrup says

DISCRETION IS CRUCIAL

Consultants Steen Hjulskov and Jørn Munk Nielsen from Hjørring Business Support Office visited the company, and when they learned about the challenges the company was facing, they suggested contacting CISS. "We had never before had contact with the university, and had never heard of CISS. But the knowledge voucher system was instrumental to us in reaching our goal," Henrik Mikkelstrup explains and also emphasizes the importance of their new collaborator's discretion. Keeping the new product close to the chest was crucial to the company during the development phase. The Knowledge from CISS has contributed to the development of an entirely new product at H. Jespersen & Søn. Henrik Mikkelstrup and Jørn Mikkelstrup

"WE WERE IN NEED OF FRESH EYES AND NEW KNOWLEDGE"

Computer scientist Jens Alsted Hansen, technical project manager at CISS, is one of the researchers who have been assisting H. Jespersen and Søn.

"Our job is to make a suggestion about how the problem can be solved – not to actually do it for them. And after a thorough analysis of their project, we realized that some changes were required in terms of software. As soon as we are done testing it, we will deliver our proposed solution to them – this will happen in the very near future," Jens Alsted Hansen explains.

READY TO ENTER NEW PROJECTS WITH CISS

At H. Jespersen & Søn they have been in contact with Jens Alsted Hansen and his colleagues at CISS so often that they are certain CISS will deliver a solution that can bring their product across the finish line.

"We certainly expect to have a finished product ready for our customers during the summer of 2010," Henrik Mikkelstrup says and continues:

"CISS turned out to be exactly who we needed. They gave us fresh eyes on our problems, and their advanced academic level means that they can help us onwards, too. Without them, our development phase would have been significantly longer and more difficult. We have established a working relationship, and I have a good feeling about CISS. If we happen to need help some other time, I will not hesitate in spending some of the company's own resources on drawing on their expertise."



H. Jespersen & Søn is an electrical contractor employing 25 people and servicing all of North Denmark. It is a modern company that undertakes all kinds of demanding jobs, not just electrical fittings for industrial construction and private homes but also more complicated facilities and large enterprise projects.

H. Jespersen & Søn contributes to the InfinIT/ Software Corridor exhibition at the Bright Green Expo 2009. Read more about the exhibition on page X. **Read more at**

www.h-jespersen.dk

Read more about the knowledge voucher system on page 4

Jens Alsted Hansen and Jan Jakob Jessen, CISS, have complete control of their Segway – and of the demonstrator model that has been constructed of it.

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Many IT and manufacturing companies could benefit greatly from using embedded software to a higher degree than what is the case now – for instance in connection with logistics, software and hardware test, or sensor networks. With the CISS ConneCT project, CISS now goes out to visit a large number of enterprises in North Denmark in order to help them identify problems and potential solutions within their lines of business

"We need to encourage more innovation in manufacturing and IT companies – and we need to draw more attention to embedded software to make trade and industry realise that it is commercially interesting. And we also need to contribute to matchmaking among enterprises – not just regionally but also nationally and internationally. And in that respect, we have a lot of experience in CISS."

So says associate professor Arne Skou, vice director of CISS. The project with this ambitious agenda is called CISS ConneCT and was launched during the summer of 2009. It is a three-year-long project with a grant from the European Regional Development Fund.

The CISS ConneCT project will focus on concrete problems that companies within a wide range of businesses are familiar with from their everyday lives. In order to gain an overview of which problems and challenges different industries experience, CISS will invite companies to so-called scenario workshops, during which the participants will get the chance to contribute with their own experiences and at the same time gain insight into existing solutions. In addition, CISS will go round the region visiting individual enterprises.

DEVELOPING DEMONSTRATORS

"During the course of the project, we will be developing six demonstrators in collaboration with companies, and the first project has already been launched. It is concerned with manufacturing and logistics, and our aim is to reach all those enterprises that are only using intelligent logistics to a small degree, but that could benefit from implementing it to a larger degree," Arne

EMBEDDED SOFTWARE FOR LOCAL INDUSTRY

Skou explains and continues:

"Once we have identified a concrete problem or challenge within the field, we go back to Aalborg University and start working on a model of a solution. This grows into a so-called demonstrator, which can be used by a wide range of enterprises."

'SEE AN IT SOLUTION'

"The demonstrators developed during the project will hopefully function as inspiration to both manufacturing and IT companies, and we naturally hope that the CISS ConneCT project will lead to several more concrete projects with the participants, starting from the demonstrators," Arne Skou continues.

But the demonstrators will serve a further purpose: "In CISS we work with embedded software, which means that it can be difficult to show others – future collaborators, political decision-makers and so on – what exactly it is that we are accomplishing. With the demonstrators, we make a number of physical models that in different ways represent CISS solutions on concrete problems in the enterprises we have been collaborating with," information and marketing manager Berit Borup Brendborg, CISS, explains.

The researchers at CISS are currently busy working on the first demonstrator. "We plan to have the first solution ready in March 2010," Arne Skou says and adds that the solution will be applicable in both manufacturing and IT companies.



In addition to intelligent logistics, CISS intends to find collaborators within the following lines of business:

- Sensor networks
- Embedded platforms
- Test and verification
- Home automation

Read more at www.ciss.dk

THE EUROPEAN UNION The European Regional Development Fund

Investing in your future

MEETINGS WITH THE DOOR AJAR

A number of Danish enterprises participate in CISS-headed projects. Some of these projects are primarily open to specifically invited enterprises, whereas others keep the doors ajar to new interested parties. In all of these projects, participants get access to the very latest knowledge



Vice director Arne Skou, CISS, is co-ordinator of a number of the projects in which CISS participates.

DaNES:

www.danes.aau.dk The Software Corridor: www.swkorridor.dk The Intelligent House www.cs.au.dk/dithus ICT Agile: www.tekkva.dk/ page359.aspx Far from all companies want to be in an open forum talking about the challenges they are facing. They may need to consider their investors – and in addition, you do not want to share everything with your competitors. Consequently, some companies might squirm at the thought of participating in research projects alongside other companies. But CISS heads a number of projects where primarily invited companies have access. The price for participating in these projects varies – but usually, the participants need to be ready and willing to play an active part, for instance by presenting a problem that the project – and not least the researchers – can help solve.

"These projects are similar in that the groups of participants consist of a mix of companies and researchers. The companies get access to the latest knowledge, and in return we as researchers gain insight into those fields that are facing challenges, and where we need to focus our work in order to help them find solutions," vice director Arne Skou, CISS, explains.

ADVANCED-TECHNOLOGY COLLABORA-TION

One of these projects is the national advanced technology platform DaNES, Danish Network for Intelligent Embedded Systems, which has CISS at the helm. The aim of the collaboration is to "determine, develop and test a model-driven and component-based development-process for the realization of the intelligent embedded systems of the future." In this project, well-known Danish companies such as Novo Nordisk and Terma participate, as well as the research institutions the Mads Clausen Institute at the University of Southern Denmark and DTU Informatics at the Technological University of Denmark.

"In DaNES, the participating companies need to be ready to present a relevant problem and spend time and resources on collaborating with the researchers on using the latest technologies in the work on solving the problem. There is an element of knowledge sharing and openness towards the other companies, which means that we reach a level of confidentiality that you do not see in typical business networks," Arne Skou points out. As a direct result of DaNES, the partners are now working on establishing an open, national network with a special focus on safety-critical embedded systems, and a number of the partners participate in a new co-Europeanproject about certification of such systems, called RECOMP (see page 14).

SHOWING GREEN SOLUTIONS DURING THE UN CLIMATE CHANGE CONFERENCE

A second project in which CISS is one of the main partners is the Software Corridor. The project, which was launched in 2008, is a national project funded by the European Regional Development Fund, and in addition to CISS, the Center for Software Innovation (CSI) and the Alexandra Institute participate.

The project has three major aims:

- **1.** Creating visibility for new software technology and showing its potentials e.g. through exhibitions
- Identifying the need for new continuing education courses for trade and industry within software development – and
- **3.** Testing new distributed forms of collaboration through projects in cooperation with companies.

"We need to carry through three projects, and we are busy with the first one right now. This constitutes a stand at the Bright Green Expo in Copenhagen at the Climate Conference in December 2009, where we will bring into focus green, environmentally-friendly IT solutions within Home Automation. We will, shortly speaking, build 'The Energy Aware House' on our stand – incidentally in collaboration with another project, 'The Intelligent House' and with the Intelligent Buildings interest group under InfinIT," Arne Skou says. The stand will constitute one of only four special activity zones at the Bright Green Expo, where the audience can interact with the exhibit. CISS will, among other things, contribute with an energy game.

CONTROLLING ELECTRICITY IN YOUR HOUSE

The 'Intelligent House' project, which also contributes to the Bright Green Expo, was launched on April 1,



2009, and like the Software Corridor, it is funded by the European Regional Development Fund. The aim of the project is to develop the prototype of a control appliance capable of interacting with and controlling a series of individual wireless systems in the house. "This will make it easy and efficient for consumers to control the energy consumption of the household – e.g. by only needing one push of a button to turn off all electrical appliances and turn the heat down, or by enabling people to turn on their washer or other electricity-consuming appliances automatically at those times of day when electricity is cheapest to produce," Arne Skou explains.

In addition to CISS, CSI, the Alexandra Institute, Aarhus University and Aarhus School of Engineering participate in the project. Right now, three companies participate, and the group is currently busy working on scenarios involving products from these three companies. But at the same time, the project partners keep the door ajar to allow other companies developing products within Home Automation or taking an interest in the field to join the project.

AGILE DEVELOPMENT (ICT AGILE)

ICT Agile is actually the second generation of a project which – briefly speaking – is concerned with optimising industrial software development processes through creativity, innovation and customer involvement. Associate professor Ivan Aaen, Aalborg University, and Arne Skou, CISS, head the project.

"The companies participating in Agile are characterised by a wish to work with a more flexible development process," Ivan Aaen explains and continues:

"What we are working on in the network is defining typical patterns in development processes, enabling the participants to improve their own processes back in their companies. As such, it is not only programmers but just as much project managers from the companies who participate in the network."

As is the case with the other projects and networks, ICT Agile has participants from educational and research institutions – and from both small and large enterprises. Products for home automation hold a large financial and environmental potential, here shown by Ole Borch, Aalborg University.



SKOV is an industry leader on the international market for climate control and production monitoring of animal production. The company develops, produces and markets systems and components for ventilation systems, livestock house air cleaning and production control for clients all over the world. **Read more at www.skov.com**



SKOV provides advanced air conditioning systems for customers all over the world

"We're picking knowledge"

One of the companies that have a long history of collaborating with CISS is SKOV A/S. The company manufactures air-conditioners for pig stables and holds a leading position on the global market. They have in fact set aside half an employee for participating in all the CISS projects and networks the company finds relevant – including DaNES and ICT Agile.

"We are not just passive participants in the meetings but pick from the knowledge we gain access to – and correspondingly, we contribute with projects and problems that enable the test of new methods. We then implement those of the results reached that are of interest to us," says Jesper Mogensen, manager of Electronics & Software at SKOV.

To SKOV, this is a matter of making the company name well-known in the university environment and thus attracting highly qualified, well-educated employees. It is also a matter of raising the knowledge level of the company – and about participating in projects that help keep the good employees at SKOV. And ultimately, it is about the company having learned that there is money to be earned by keeping in close contact to researchers and other companies.

"And of course it is an advantage that CISS is far more focused on industry than what is usual in the university environment. It is my experience that they are speaking our language," Jesper Mogensen emphasises.

INNOVATION NETWORK SETS THE WHEELS TURNING

Apart from being Denmark's only national innovation network within IT, InfinIT is also a kind of workshop where enterprises can bring their problems, which can then turn into concrete projects



InfinIT was launched in March 2009 and is a four-year-long project financed by a grant of DKK 20 million from the Danish Ministry of Science Technology and innovation. The partners behind InfinIT are: CISS/Aalborg University, the Alexandra Institute, Center for Software Innovation, Department of Computer Science/Aarhus University, DTU Informatics/ Technical University of Denmark, the IT University and Knowledge Lab/ University of Southern Denmark

Read more at www.infinit.dk "The activities in InfinIT rest upon experiences from its predecessors, the advanced-technology networks Mobile Systems and Komlalt, so in March 2009 when we launched the innovation network, we knew that a very efficient tool would be setting up interest groups within specific fields, in which both enterprises and researchers participate. Academically, InfinIT covers the entire spectrum from 'Embedded Systems' over 'Mobile and Pervasive Systems' to 'Future Internet', and within this overall strategic framework, we have set out four areas with special focus and activities, namely 'Platforms', 'Methods, techniques and tools', 'Positioning and tracking' and 'Pervasive collaboration and learning'. Our current eight interest groups all stem from these focus areas and our work within them."

So says innovation consultant Rikke Koch from the Alexandra Institute, one of the major actors in the innovation network. She works in the secretariat of InfinIT, which already – after only nine months – has a high level of activity. Not least because the network takes the word 'innovation' very literally.

"One of the purposes of the interest groups is to initiate mini-projects with some of the participating enterprises. Our goal is to initiate eight projects a year, and in short this happens by the enterprises bringing us some tangible problems that we can collaborate on solving," says director of CISS Kim Guldstrand Larsen, who is also the director of InfinIT. And he invites enterprises to contact InfinIT if they have a challenge the network might help them sort out.

NEW MARKETS AWAIT

"The mini-projects give us the chance to establish new contacts to enterprises who may not usually consider using researchers in their development processes. And a number of enterprises can join these mini-projects together," Kim Guldstrand Larsen says and adds that it can be a rather barrier-breaking experience for an enterprise to enter a project – or, for that matter, join an interest group – in which they need to share their knowledge with other enterprises.

"But it is both important and necessary for the individual enterprises to dare look beyond their own horizons. The reward is there – in the shape of improved products, a bigger market etc. And in that context, collaborations may be the way to open new doors," he points out.

And the same goes for the knowledge institutions participating in InfinIT. "We have different fields of specialty and can draw on each other's knowledge. To give one example: CISS are among the leading players within development of embedded systems – which are a prerequisite for ITU's ability to develop new services," Rikke Koch explains.

MORE COMPANIES ARE ALWAYS WEL-COME

In the many interest groups that have appeared under the InfinIT heading, there is a natural emphasis on research fields concerning climate, environment and energy.



"For instance, we have an interest group focusing on intelligent buildings and one focusing on green IT," Rikke Koch says. Through InfinIT, a number of the participants in the In-

telligent Buildings interest group have got the exclusive opportunity to present some of their products in an activity zone at the upcoming Bright Green Expo in Copenhagen during the 2009 Climate Conference. The activity zone allows the audience to interact with the products and technologies presented and thus offers a unique hands-on experience. "By setting up an activity zone rather than a typical exhibit, we offer the participating companies the opportunity to gain a higher level of visibility. This kind of exhibit is more visionary and playful, and we hope it will invite the audience to enter into dialogue with us," Rikke Koch explains.

This is only one among a wide range of interesting activities going on in the InfinIT interest groups. The members of the groups number companies of all sizes and from all over the country – and the network is continually on the lookout for new partners. "This also means that we do a lot of extroverted activities to draw attention to the network – newsletters, thematic days, promotion through an active website, social networks and so on," Kim Guldstrand Larsen explains.

BORDERLESS KNOWLEDGE

"Three to four years ago, the EU decided to establish a number of so-called Joint Technology Initiatives within certain fields – and among the fields chosen as special focus areas is embedded systems. The initiative, whose purpose is to strengthen European research and development of embedded systems, is called ARTEMIS (Advanced Research and Technology for EMbedded Intelligence and Systems), and one of the primary activities within ARTEMIS is supporting co-European research and development projects.

Since 2007, CISS has been working with a number of other Danish players within the field – among them the Technical University of Denmark and the Confederation of Danish Industry – in order to identify Danish enterprises that might be interested in taking part in such co-European projects. The forum for this is the D-ARTEMIS collaboration (Danish ARTEMIS), and this has led to the involvement of Danish enterprises in four project applications to the EU in 2009. The enterprises in question range from companies that CISS was already collaborating with to entirely new companies who have seen the potentials in collaborating with the topmost enterprises and researchers in the EU," vice director of CISS Arne Skou explains.

The consortium behind one of these proposals, in which CISS takes part, received a large grant from ARTEMIS at the end of 2009, and the project, which bears the name RECOMP, will be launched in the near future.

JOINT RESEARCH PROJECTS

But ARTEMIS is far from the only international dimension of CISS' activities.

"Whereas the driving force of ARTEMIS is the needs

Across borders, researchers and enterprises collaborate on developing embedded software solutions – and CISS is always present where things take place

of trade and industry, ARTIST Design is a European Network of Excellence that brings together the most outstanding European research environments and enterprises within embedded software," director of CISS, professor Kim Guldstrand Larsen explains.

ARTIST Design brings together the highest competences in Europe within the field with the purpose of creating a highly competent research community that can support the research and development of embedded software and the dissemination of knowledge about it. Among other things, this is done through summer schools, courses and workshops. The activities in ARTIST Design are divided into seven fields or clusters, of which the Modelling and Validation cluster is headed by CISS.

COLLABORATION IN CHINA

Among the places where ARTIST Design arranges their summer schools is China, where Kim Guldstrand Larsen and professor Jan Madsen from the Technical University of Denmark were among the main lecturers in the summer of 2009. This gave them the opportunity to make contact with researchers at the Tsinghua University in Beijing, which is the foremost research facility within embedded software in China.

"Our aim is of course to strengthen our collaboration with the Chinese researchers – and perhaps attract Chinese students to a stay at CISS," Kim Guldstrand Larsen says and continues:

"In addition, the Danish National Research Foundation wants to set up a collaboration with the Chinese Natural Science Foundation with the goal of establishing an ICT research programme that joint Danish-Chinese consortia can apply to. In this connection, Flemming

ARTEMIS:

www.artemis-ju.eu ARTIST Design www.artist-embedded. org Quasimodo: www.quasimodo.aau.dk



Founders of Seluxit, Morten Pagh Frederiksen and Daniel Lux, are pleased with their collaboration with CISS and the doors this has opened for the company both nationally and internationally.

Nielson, Institute of Mathematic Modelling at DTU, and I went to Shanghai to establish contact."

MODELS STRENGTHEN THE COMPETI-TIVE POWER

The place to find the major EU subsidies is within the EU's framework programmes. One of the projects under the 7th Framework Programme (which also funds ARTIST Design) is the Quasimodo project that has CISS at the wheel. Quasimodo means ' Quantitative System Properties in Model-Driven-Design of Embedded Systems', and the aim of the project is to investigate the possibility of developing models capable of taking over part of the work on measurements and experiments in the course of the development process when designing new software – and consequently save valuable time.

"It is our goal to enhance the competitive power among European enterprises by use of models that enable them to design complex systems fast and cheaply," explains associate professor Brian Nielsen, CISS, who is the coordinator of the project.

The project, which has an overall budget of 2.7 million Euros, has received 1.9 million Euros from the EU's 7th Framework Programme. And the co-European team brought together in Quasimodo is a strong one; apart from CISS, a further eight partners participate: Le Centre National de la Recherche Scientifique, France, the Universities of Aachen and Saarland, Germany, Université Libre de Bruxelles, Belgium, Embedded Systems Institute, Holland – in addition to three companies: Terma, Denmark, Hydac, Germany, and Chess, Holland. Seluxit provides world-class intelligent solutions for saving energy in private homes and public buildings in the shape of sensors, software and wireless control systems. The company was founded in 2006 and has four employees.

Read more at www.seluxit.dk



"CISS opens doors outside Denmark"

The company Seluxit ApS in Aalborg, which develops wireless devices for controlling heating, electricity etc. in private homes, takes part in several national and international projects along with CISS.

"The collaboration with CISS opens doors – both on a national and an international scale. They give us the opportunity to expand our network, and the international projects constitute a show window for us that enables us to initiate dialogue with large international enterprises that a small company such as ours would not otherwise have access to. And last, but not least, we get access to the very latest technological knowledge," managing director Daniel Lux, Seluxit ApS says. He continues: "One of the advantages of having made contact with CISS is that now, they call us when they are involved in a project or an application that is relevant to us, and ask if we would like to participate in it."



"We benefit from CISS' advanced academic level and their high level of activity," emphasises Grimur Lund, chairman of the North Jutland ICT collaboration BrainsBusiness – ICT North Denmark. He pinpoints CISS as one of the significant players in the network

CISS ADDS MUSCLE TO BRAINS-BUSINESS

Not many regions are capable of the kind of support for its trade and industry that North Denmark offers. A very visible example of this is the ICT collaboration BrainsBusiness, which is a partnership between the Municipality of Aalborg, the North Jutland Region, Aalborg University and ICTNORCOM – the strong ICT business forum that covers all of North Denmark. The purpose of BrainsBusiness is to make the world-class ICT trade and industry of the area even more visible, both within the region and on a world-wide scale, and to strenghten North Denmark's position as one of the leading ICT regions in Denmark.

"It is to a very large degree the players in BrainsBusiness who set in motion the activities that the ICT trade in North Denmark benefit from. And in this connection, CISS is one of the significant players. The centre is internationally renowned for its advanced academic level, and they are very good at being extroverted – at going out there establishing new collaborations with enterprises that may not usually consider ICT as an element of their work process," Grimur Lund points out. He holds the position of managing director of the logistics company Logimatic, which was appointed Entrepreneur of the Year in North Denmark in both 2008 and 2009.

LESS PAPERWORK AND TWADDLE

Grimur Lund describes BrainsBusiness as "a very efficient marriage of convenience", which has now existed in almost two years.

"Basically, the collaboration is anchored in the ICT trade and industry, which in North Denmark has been brought together in ICTNORCOM, in Aalborg University – and in political decision-makers in municipalities and the Region, who support trade and industry

through a targeted industrial policy. We are the sum of the many players," he explains and continues:

"One of the reasons that we are ahead of other regions in terms of setting up a joint strategy for a specific trade is probably that we have spent very little time on twaddle and formalities. And in this connection, CISS is in the frontline as well: There is often a lot of paperwork involved when a company enters a collaboration with the university, but in this respect CISS is very solutionoriented – they have an understanding of the conditions of the corporate world and are very accommodating."

STRONG EUROPEAN ICT CLUSTER

Grimur Lund is convinced that the partners in Brains-Business have a common understanding that the growth of the North Denmark ICT trade and industry and its ability to attract new businesses and highly qualified employees to a very large degree depends on the ability of the individual enterprise to put aside their modesty and tell the world about their successes.

"It is a law of nature that people, enterprises and money flock to places where things become successes. CISS has always been successful – and excels at telling the outside world about it," he points out. "We hope to be able to use the experience that CISS has accumulated in BrainsBusiness, so that we can show the entire country, and Europe as well, the many varied, world-class competences we have here – both within research, education and industry!" he finishes.

One of the major goals for BrainsBusiness is for North Denmark to become one of the most highly renowned ICT regions in Europe in 2015. And Grimur Lund is convinced they will succeed – not least thanks to active players such as CISS.



What is BrainsBusiness?

BrainsBusiness is a private/public partnership within the field of ICT, which exists to support and develop the ICT trade and industry in North Denmark. The goal is to achieve visibility, innovation, growth and jobs by collaborating across traditional barriers and instigating knowledge sharing and knowledge dissemination – both among enterprises and between the research and educational institutions and enterprises.

The partnership consists of representatives from the Municipality of Aalborg, the North Jutland Region, Aalborg University – and thus CISS – and ICTNORCOM Business Forum.

Read more at www.brainsbusiness.dk



Satisfied collaborators at the signing of the collaboration agreement in November 2009:

Back, from the left: Vice-Rector Jørgen Staunstrup from the IT University, Head of Department at DTU Informatics, Kaj Madsen, Pro-Dean of research at Aalborg University, Lene Lange, Kim Guldstrand Larsen, CISS, vice head of centre of MT-LAB, and Pro-Rector at DTU, Knut Conradsen. Front, from the left: Chairman of the Villum Kann Rasmussen, Foundation, director Lars Erik Kann-Rasmussen and

Flemming Nielson, DTU, head of centre of MT-LAB. >>

CISS students associated with MT-LAB receive the Roblon award

Three students from CISS, who contribute actively to the work in MT-LAB, recently received this year's Roblon award for their project on C code programming. In the project, the students combined two different techniques within modelling: model checking and static analysis. In addition to the honour, the three students received DKK 100,000. The award was presented at AAU's 35th anniversary celebration on November 3, 2009.

Mads Christian Olesen, Andreas Engelbredt Dalsgaard and Martin Toft

COLLABORATION ON FUNDAMENTAL RESEARCH

Three competing research units have joined forces to establish a Centre of Excellence called MT-LAB. The centre works on finding a more efficient way of using models in software development

Imagine that you are sitting in the cockpit of an airplane. At 30,000 feet, the instrument board announces: "The program has encountered a problem and needs to close. Please restart." There is no way we would accept something like that – yet that is what many who work with slightly less safety-critical IT have to live with every day.

In Denmark, we have three research institutions working with the use of models in software development – models that can contribute to locating errors in the programming process. Those are the kind of errors that may cause the company PCs to shut down in the middle of a crucial transaction. The three institutions in question are Aalborg University (AAU), the Technical University of Denmark (DTU) and the IT University (ITU). Usually, they are rivals, but at the end of 2008, they established a joint Centre of Excellence called MT-LAB; MT being short for Modelling of Information Technologies.

RESEARCHERS THINKING OUTSIDE THE BOX

"Excellent research arises in the area of tension between what you are capable of and what you cannot do. If we conduct our fundamental research each within our own unit, there is a danger that we will walk around thinking in grooves. By collaborating, we are shaken out of our usual thought patterns – someone will question what we are doing and force us to think outside the box. When we are brought together across competences, we will challenge each other," director of MT-LAB, professor, DSc Flemming Nielson, DTU Informatics, says. He continues:

"There is a need for the universities to perform fundamental research – trade and industry cannot be expected to perform that task. And Bill Gates, founder of Microsoft, said the same thing when he proposed that more funds should be set aside for fundamental research. Because it is fundamental research that forms the basis of the really big commercial successes – such as Google, which, all things considered, merely consists of search algorithms."

MODELS NEED TO INTERACT

At CISS, they are pleased with the collaboration and the results it may engender.

"There's a forest of different models. Our job at MT-LAB is first and foremost to study all these models with the purpose of finding out how to use them more efficiently. We need to make them interact, so to speak," director of CISS, Kim Guldstrand Larsen, who is vice director of MT-LAB explains. He continues:

"We need to investigate methods for formal verifica-





No more butting heads – former research rivals now collaborate in MT-LAB. Kim Guldstrand Larsen and Flemming Nielson.

tion of modern advanced software – in embedded systems as well as in other contexts – and we will be combining models known from computer science with traditional mathematical modelling as it is known from control theory, among other things."

Flemming Nielson explains how this can be converted into solutions that can benefit us all:

"There has been a lot of debate in the media here in

Denmark about the invitation for tenders for the ambulance services different places in the country. Imagine if, prior to making the decision, the regional authorities were able to calculate whether the response times that individual contractors promise to keep are possible in practice with the number of ambulances and emergency vehicles available."

A VKR CENTRE OF EXCELLENCE

The MT-LAB project will run for five years and has a budget of DKK 50 million. Of this, the Villum Kann Rasmussen Foundation has contributed with DKK 25 million.

Read more about the project at: www.mt-lab.dk



EMBEDDED SOFTWARE - RESEARCH AREAS

Embedded software – or intelligent embedded software, as it is also known – constitutes software that is integrated in mechanical appliances. This could be a refrigerator, a blood pressure apparatus, a car or a production robot – that is, appliances which are not in themselves computers. By using embedded software rather than e.g. mechanics or electronics, it is possible to infuse the appliance with far more capabilities and potentials for use – and to improve its performance, stability and security.

ON THE FOLLOWING PAGES, YOU CAN READ ABOUT OUR RESEARCH AREAS:



HW/SW CO-DESIGN

There is no law of nature stating that hardware and software will always work together. In fact, it is often the case that one part is developed first, whereupon the other part needs to be adapted to this. But at CISS, we work on making the two development processes simultaneous.

Thus, the purpose of our research within this field is to develop software and hardware that perform optimally together, offering companies reduced production costs, reduced energy consumption or an end product that is smaller than what is usually the case. We work on developing methods of analysis that perceive hardware and software development as one unified process and that are continuously capable of assessing whether the products will perform as intended.



MODEL-DRIVEN DEVELOPMENT

Developing a prototype just to discover that it does not function as intended is both expensive and frustrating. Any developer wants to avoid problems like that, and one way of preventing potential problems is to set up a mathematical model of the product and make calculations on whether it will function according to plan – even before the company starts developing the actual hardware and software for the product.

At CISS, several of our researchers and PhD students work with model-driven development as well as with model-driven tests where we set up a model, develop software on the basis of it and subsequently test the software against the model to test whether the software functions according to our calculations. Everything with the purpose of heightening reliability and minimising the number of potential errors in the projects.

CISS IS AMONG THE LEADING RESEARCH UNITS WITHIN EMBED-DED SOFTWARE SYSTEMS, NOT JUST IN DENMARK BUT IN EUROPE.

We work within different research areas under the heading of embedded software. Within each area, we conduct research to gain new knowledge and develop new methods and processes to the benefit of our collaborators.

INTELLIGENT SENSOR NETWORKS

Usually, sensors – e.g. in an indoor thermometer – are relatively simple pieces of electronic equipment capable of sending one specific type of information to a receiver. But this does not mean that they are incapable of solving fairly complicated tasks – they just need to be able to cooperate.

At CISS, we work on creating systems that are capable of gathering information from a large number of intelligent sensors. This means that a system does not only collect and disseminate single pieces of information – it will also be able to compare the information gathered and subsequently provide new information or take action on the basis of the information received. In addition, we work on developing networks of sensors capable of determining whether their measurements are correct or not – and, if they are not, of reporting themselves as faulty, thus making the rest of the system ignore the information from that sensor until the error has been remedied.

EMBEDDED REAL-TIME OPERATING SYSTEMS AND PLATFORMS

A lot of embedded software performs tasks at specific times or with very strict intervals. Examples of this are the autopilot of a plane or the radar system on a ship. The systems used in such appliances are often subject to very strict requirements concerning reliability and accuracy, in the sense that they must deliver exact information with accurate, often very small intervals. In addition, they need to function while being subject to various challenges such as exposure, size and the complexity of their tasks – and the systems need to be able to continue solving their tasks, even if errors occur. Finally, the operating systems must be able to function for many years, which means that being able to attain spare parts and updates is a prerequisite.

On the one hand, CISS works on evaluating existing operating systems developed for embedded systems, and on the other, we work on developing and testing new development possibilities, e.g. the use of Open Source standards in such systems.

SAFETY- AND SECURITY-CRITICAL SYSTEMS

At CISS, we work with both safety-critical and security-critical software systems.

Concerning safety – reliability – we work on locating errors (occurred or potential) and on setting up and testing models in order to document whether the systems live up to the requirements placed upon them. In addition, we work on 'temporal validation' – e.g. how long it takes from the moment when a system receives information till it reacts. The focus of our work within safety-critical systems is naturally placed upon predicting and thus preventing potential errors and upon developing systems that continue to work even if errors do occur.

Concerning security – data security – we work mainly with devices connected to the internet. We work on creating a balance between a high level of security and accessibility for the users – in order to make sure that the people working with the devices and programmes can still work with no obstructions, while the system keeps out unwelcome visitors.



The last research areas









TEST AND VALIDATION OF EMBEDDED SYSTEMS

Embedded software systems are becoming more advanced every day, and consequently an increasing number of things can go wrong. Therefore, almost fifty percent of the time it takes to develop the systems is spent on testing programmes. In terms of reducing costs and avoiding wasting time and resources on developing products that do not work, manufacturers will be able to benefit hugely from being able to test the systems as early as possible in the development process.

At CISS, we work on model-based testing and validation, enabling a manufacturer to start calculating where potential errors may occur, as early as in the planning and development phase or when a design model has been constructed – and thus remedy the errors before the production of the actual product has been initiated or further development on the model has been carried out.



OBJECT-ORIENTED ANALYSIS AND DESIGN

Embedded software is often developed for specific products. This means that it is not enough for the developers to consider the function the software is supposed to fulfil – it is also necessary to consider both the hardware and mechanics of the product during the development process. At CISS, we study the methods within object-oriented analysis and design that are most suitable for the challenges that researchers and manufacturers are facing in terms of software development.

Our tools for analysis and design can be applied early in a company's development process like a kind of 'architectural drawing' in which we describe the various challenges and issues the company may encounter in terms of software, hardware and mechanics – and, not least, the interaction between these three elements. This leads to a shorter development time and a product of higher quality.



HIGH-LEVEL PROGRAMMING LANGUAGE

Programmers' choices of programming language are often a matter of habit – and very much a matter of personal preference. Thus, they may not necessarily choose the optimum language for a specific task, but rather the one they prefer working with. At CISS, we participate in a series of projects focusing on making the best choice of programming language for specific tasks.

The choice of programming language depends on many things. A language that might enable the programmer to save time during the programming process itself is not necessarily the best choice in terms of the so-called level of abstraction – the distance between the programming language and the machine language that the hardware in question understands. Sometimes, a 'translator' is needed between the two, which bears the risk that details may be lost in the translation process.

In general, the choice of programming language is a question of finding a balance between the level of abstraction and an efficient utilization of the hardware resources. Our' research can help companies find the exact language that is optimal in terms of the tasks they need to solve.

READ MORE AT WWW.CISS.DK

OPTIMUM SCHEDULING

Optimum scheduling concerns mathematically planning the working procedure of a product or appliance in connection with performing a specific function. At CISS, we work with a wide range of approaches to scheduling, since the demands on embedded software systems vary markedly. Some systems are concerned with performing a task within a set deadline, and in such cases, classical scheduling theory can be applied. But at CISS, we also take one step further and work with dynamic scheduling which takes into account the fact that things may change during the process.

The basic idea is that scheduling makes the system or product function optimally with regards to its given task and the company's guidelines concerning e.g. reduced energy consumption, reduced wastage or potential storage space in the product.

WIRELESS NETWORKS

Wireless networks are the future – not just in connection with computers or Bluetooth technology for mobile phones, but also in connection with various sensors and other technical devices. However, it is a necessity in this regard to consider the energy consumption of the network – otherwise, the expenses and environmental strain may rapidly counteract the advantages of a potential heightened level of efficiency.

At CISS, we work on developing sensors that are self-sufficient in terms of energy. As the sensors are wireless, we work on using alternative forms of energy – e.g. solar cell energy or energy generated by temperature variations in the surroundings of the sensors. With time, we hope to develop sensors so cheap and reliable that they can be used in ordinary companies and homes and for outdoors environmental surveillance and other similar tasks.

IT IN AUTOMATION

Many companies have started to replace mechanic elements with intelligent software. This has several advantages: first of all, products with embedded intelligence and high-technological knowledge are more difficult to copy (and thus make cheaper copies of), and secondly, the manufacturers achieve higher levels of quality, heightened precision and higher levels of security and safety. In addition, they will often be able to manufacture smaller products and consequently obtain a reduced consumption of materials and lower production costs, which eventually also lead to a cheaper and more cost-competitive product.

One example of this is the growing use of IT for the regulation of mechanical processes. In this connection, using intelligent software provides a clear advantage, since with this kind of software in autonomous systems, the system can continue to function even if a part of it breaks or fails. The system itself figures out how to solve its task without the faulty part, which is a huge advantage in hard-to-reach or highly safety-critical systems.

At CISS, we perform research on IT in automation within many different kinds of trades and, hence, we have a high level of knowledge and competence in the area. Thus, we encounter many different approaches to the field, both practical and theoretical, and this constitutes a basis for synergies and experience accumulation for use in further research and product development.









CISS

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