



Centre for Embedded Software Systems

CISS
BUILDING
BRIDGES





Centre for Embedded Software Systems

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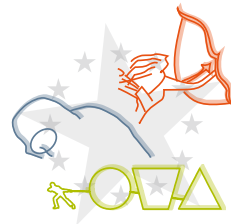
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CISS – a leading embedded software research centre

by Managing Director of CISS,
Professor Kim Guldstrand Larsen

In 2003, CISS – Centre for Embedded Software Systems – was established at Aalborg University, Denmark. Since then, the centre has expanded its activities within both research and industrial collaboration and has by now achieved a position as one of the leading embedded software research centres in Europe.



Kim Guldstrand Larsen

CISS is rooted in Aalborg University's Department of Computer Science and Department of Electronic Systems, which means that we have a number of world-class researchers at our disposal. In addition, the combination of competences that our researchers possess means that we have a unique approach to embedded systems; namely one which unifies hardware and software development in research and development processes, unlike typical approaches which keep the two types of development processes apart. Our research and development work is gathered in 11 major research areas, covering a large part of the overall field of embedded software.

Focus on company needs

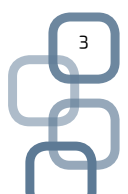
It has been one of our aims from the very beginning that our research and the knowledge and experience that our researchers possess should be made available for the Danish industry, in which

an increasing number of companies are dependent on embedded software systems, some in terms of their actual products, some in terms of the machinery used during the development or manufacturing processes or the day-to-day running of the businesses. Accordingly, we offer a wide range of collaboration forms, and if a company approaches us with a problem or challenge that they need our help to solve, we can provide a collaboration solution which matches their needs and capabilities.

Our extensive collaboration with industrial partners is a clear advantage, both for us and for our collaborators, since they get the chance to take advantage of our knowledge and competences, and we get the chance to gain insight into the everyday challenges and problems that the companies face. In this way, we can focus our research and adapt it to industrial needs – to the benefit of all.

Collaboration beyond regional and national borders

Our activities go beyond regional and national borders, though. Our collaborators already number business and research partners from all over Denmark and from Europe as well, and we are engaged in a number of EU research collaborations, among them ARTIST², ARTIST DESIGN, Quasimodo and Multiform. We are continually expanding our activities and hope to get even more international partners in the future. This magazine will serve to give future collaborators and other interested parties an insight into our wide range of activities, primarily our research projects – which number lines of businesses as varied as agriculture, animal welfare, computer games, mobile technology, health and environmental concerns – as well as our activities within EU-funded research initiatives.





CISS VIP is a 'hothouse' for embedded systems – a place where ideas and products can be developed and grow with a helping hand from CISS' researchers

CISS VIP – close to industry

More and more companies need to be able to bring highly qualified and specialised researchers into the company, allowing them to participate in the maturation and development of prototypes of new products.

"The current demand for research-based development 'on demand' is something we in CISS would love to meet, and that's why we have created CISS VIP. Here, companies can draw upon the knowledge residing within CISS on consultancy terms, which enables our researchers to offer a focused effort in close contact with the products and with the companies themselves. Most important for the companies is the fact that when CISS, via CISS VIP, is brought in to develop a certain kind of technology, the company keeps full ownership of the product being developed," Managing Director of CISS, Professor Kim Guldstrand Larsen explains.

Researchers with their fingers on the pulse

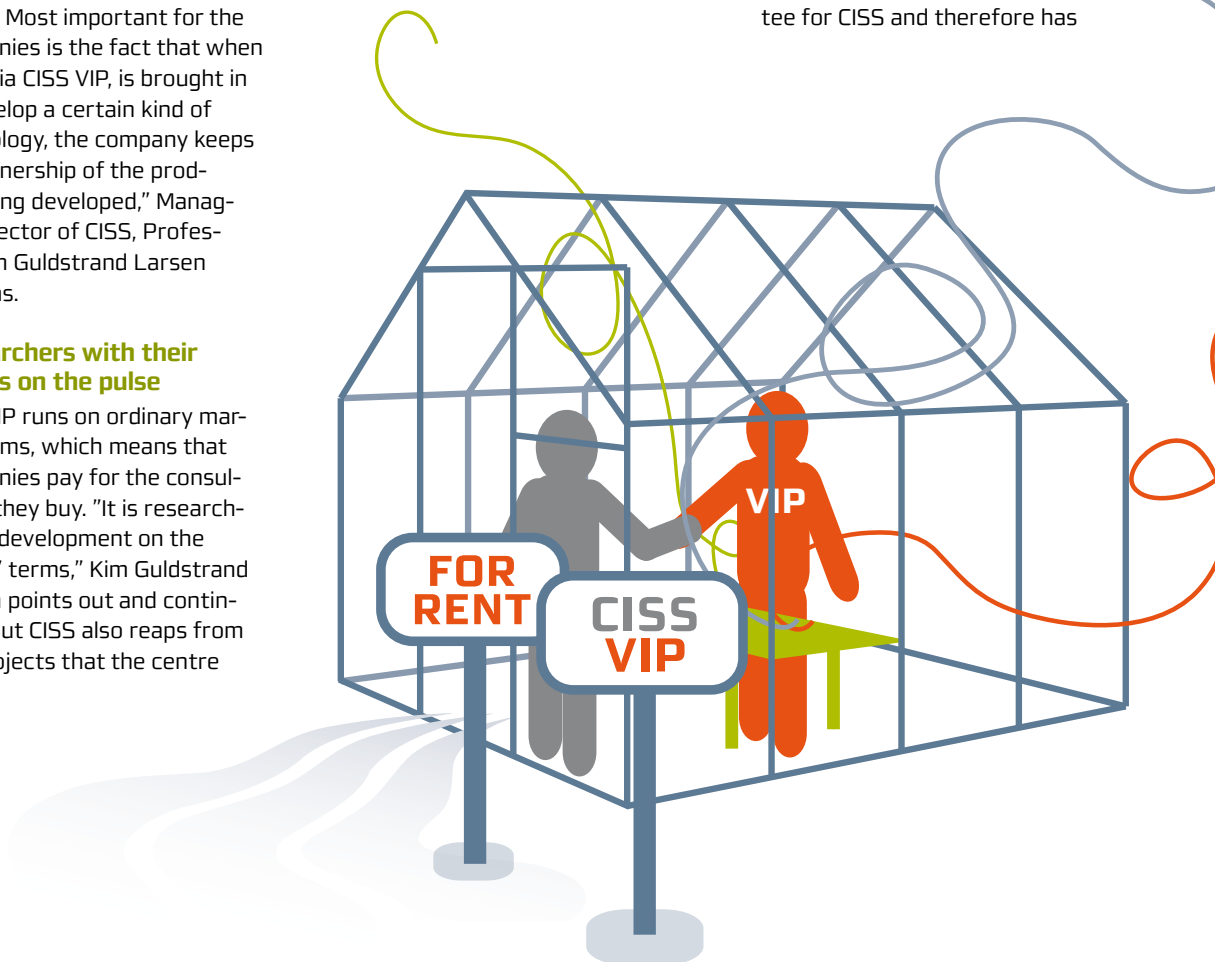
CISS VIP runs on ordinary market terms, which means that companies pay for the consultancy they buy. "It is research-based development on the clients' terms," Kim Guldstrand Larsen points out and continues: "But CISS also reaps from the projects that the centre

acquires through CISS VIP. It gives the centre's researchers and PhD students the chance to keep their fingers on the pulse in terms of where and how their research can be applied in practice. They gain knowledge about where to focus their research in the years to come – and that of course makes the researchers even more desirable for the Danish companies" Director of the Danish company S-Card A/S, Steen Rasmussen, agrees. "Within the business world, there is a great need for access to the research compe-

tences that for instance CISS possesses. And at the same time, it is important for the university to gain knowledge about the development tendencies within the business world," he emphasizes.

Specialists in security

S-Card manufactures chip cards for all types of card-employing lines of businesses in Denmark – for instance credit cards, SIM cards, phone cards, coin cards, admittance cards and industrial applications. And apart from the fact that Steen Rasmussen is on the executive committee for CISS and therefore has



an in-depth knowledge of the centre, the company has also made use of the centre's knowledge several times. "Among other things, we have used CISS in connection with a project concerning cryptography – and apart from the people at CISS, there are in fact very few people who possess the necessary knowledge. In our line of business, security is crucial, and through CISS, S-Card gets access to the latest research," Steen Rasmussen explains. He continues: "When it comes to research-related knowledge, it is a clear advantage to have a local collaborator like CISS, and it is of great value that we are able to bring in researchers on the basis of single projects the way we can do it now in CISS VIP. It's a huge advantage to be able to assemble a team consisting of people from CISS and our own employees and have them working together on a concrete development project!"

Need for knowledge about industry

Steen Rasmussen knows that a service like the one CISS offers is quite unique. "The whole debate about the liberty of basic research versus the needs of industry is somewhat of a minefield. We need to allow basic research its liberty – but at the same time, I think it is important that researchers are aware of and understand the conditions and needs that exist within industry. Here, CISS has found the balance and is a brilliant example for others to follow. Among other things, the centre has by now educated 20 PhDs who work – or have been working – within industry," Steen Rasmussen points out and continues: "I'll go to the length of saying that the people at CISS are specialists in understanding the conditions of industry – and an increasing section of the business sector knows that this is the place to go to get specific problems solved. I dearly hope that CISS will be able to go on attracting new researchers who want to work in the borderline territory between research and industry."

Meet CISS VIP's chief developer



Henrik Vie Christensen

The man who has been running CISS' special project department, CISS VIP, since August 2007 is a person holding a comprehensive CV. Chief developer Henrik Vie Christensen holds both a practical craftsman's background and an academic one.

"That's right; I originally graduated as a skilled auto-matics mechanic and then studied to become an electronics technician. Afterwards, I graduated as a MSc in maths with regulation technology as my supplementary subject, and then I did a PhD from the Department of Electronic Systems," Henrik Vie says. Along the way, the now 37-year-old Western Jutlander spent some time at the machine shop Brio in Thisted, at the windmill factory Vestas and at Coloplast, who among other things manufacture ostomy bags. But in recent years, his place of employment has been Aalborg University.

"My task at CISS VIP is to help companies solve the problems and challenges they are facing. One way to do this is by finding the persons here at the university who are most knowledgeable about their particular type of challenge – and ensuring that we are providing the company with the best possible service throughout the process," Henrik Vie explains. Even though he is a member of the CISS team, Henrik Vie's office is located a few hundred meters away, at Fredrik Bajers Vej where the university's engineers can be found. "Here, we have the facilities for solving hardware-related problems too, so that we can provide our business clients with the widest possible range of service," he emphasises.

Read more about CISS VIP at www.ciss.dk
– or contact chief developer
Henrik Vie Christensen at +45 9940 8767

CISS VIP:

Controlling huge ships

When large passenger or cargo ships manoeuvre in narrow straits or have to moor at keys in foreign harbours, the pilot's local knowledge and gut feeling are to a large degree responsible for ensuring the success of the manoeuvre.

As a rule, he can get a lot of help and support from the already-existing device, a SEAMate1A® that enables him to read all the ship's instruments, but things such as the ship's braking distance and leeway caused by currents or wind – and, consequently, how much space the ship needs when turning around its axis, among professionals called "rate of turn" – those he needs to know by heart. The company that has manufactured the pilot's wireless helper, SEAMate1A®, is called Mølgaard NetCom A/S and is located in Thisted in Northern Jutland, Denmark. And they would be happy to develop a decision support system for the pilot ena-

Mølgaard NetCom A/S

Mølgaard NetCom A/S is an IT company based in Thisted with around 40 highly engaged employees. The company's area of speciality is networks, security and communication solutions – that is, e.g. servers, networks and IP telephony solutions. Apart from the above, the company's Marine Division has developed and now markets the product SEAMate1A® along with the SEAMate1ALite® designed for the pleasure boat market.

Visit the company at: www.molgaard.dk

bling him to calculate the ship's "rate of turn" – maybe by use of a combination of gyro and GPS. "Therefore we grew interested when trade promotion officer Flemming Toftdal Olesen, Thisted, told us that it was possible for us



Søren Madsen

to get a visit from two guys from something called CISS at Aalborg University. We had never heard of CISS, but Flemming spoke so warmly about them that we chose to set up a meeting. The visitors were Managing Director Kim Guldstrand Larsen and vice director Henrik Schiøler – and it quickly became an interesting conversation," Managing Director Søren Madsen from Mølgaard NetCom A/S tells.

It is possible!

The visit at Mølgaard NetCom A/S took place at the end of 2006 and led to an agreement between the company and CISS stating that over a project period of four months, CISS was to scan the market in order to locate solutions enabling the expansion of SEAMate1A® to also include the "rate of turn" feature. This was to take place under the auspices of the newly-started CISS VIP, and several persons at Aalborg University became associated with the project: Vice director in CISS, associate professor, Henrik Schiøler, Professor Kaj Borre, The Department of Communication and Psychology, and PhD student Kazimieras Bagdonas, CISS. "The project was initiated in the spring of 2007, and when it ended, we had proof that what we wanted to do was possible. We can actually expand our existing product, SEAMate1A® to include a further

"rate of turn" feature. As a rule, it is the pilot's experience that counts where a ship's "rate of turn" is concerned – but a technical support device will always be able to help him out and confirm his proposed course of action. So far so good – now for the next phase: What will the production costs of the finished product be, and what price is acceptable for the market? It needs to be cost-efficient," Søren Madsen adds.

Access to acute minds

While Mølgaard NetCom A/S consider whether to continue working on the expansion for SEAMate1A®, Søren Madsen evaluates the company's first encounter with CISS VIP. He makes no secret of the fact that there is a huge difference between the work methods and principles in an industrial development department and those used in the world of research at the university, and that it takes some time for a company to grow accustomed to that. But the advantages of collaborating with CISS are definitely worth considering. "We got four months' research to a more-than-favourable price, not to mention the possibility of utilizing some of the most acute minds within this field. And at the same time, we had access to a range of state-of-the-art test facilities," Søren Madsen emphasises.

GamesOnTrack A/S...

...is a new company within the electronics and games business whose purpose is to create games – computer and other – with a high level of physical interactivity by combining virtual and physical worlds. See www.gamesontrack.com

CISS VIP: Computer games in the real world

For two decades, children of all ages have been stuck to their computer screens, entertaining themselves by playing computer games...

...from the simple Pac-Man played on a Commodore 64 in the late 80's to World of Warcraft and other advanced games today. With game consoles such as the Nintendo Wii, games have now become more active. Many new games take place in the living room rather than in front of the computer, allowing players to play rock guitar, golf, tennis and much more. But now a newly-founded company, GamesOnTrack A/S, has initiated a development project to release the computer game from the computer to an even higher degree.

"Our mission is to go one step further, make the interactive game even more physical and for instance make it possible for the players to program the devices they're playing on. At the same time, the gaming device needs to be wireless, allowing players even more freedom of movement," Managing Director and founder of GamesOnTrack, Niels Bo Theilgaard explains.

High-speed positioning

If the games are to take place in the real world in which the player is located, rather than in the virtual on-screen reality, the game needs to be able to 'read' its physical surroundings. And not only does the game need to determine its location in physical space – it also needs to do so

super-fast. Even when the player is moving.

"First of all, we need to be able to perform indoor positioning with a higher level of accuracy. Therefore, I spoke to the Managing Director of CISS, Kim Guldstrand Larsen, about finding a solution faster and more precise than a GPS. As a result, we – and three students – have been working on a model with a motor-driven moving object which measures its location by using a number of markers placed around the room. The system is called Radio Frequency ID, and it is used for e.g. registering goods in storage areas. The small 'tags', markers, can store lots of data – more than would be possible in for instance bar codes," Niels Bo Theilgaard explains.

They succeeded - almost

The goal was to reach an accuracy of one cm per second – but they didn't quite succeed in that. During the project, they reached an accuracy of 10 cm per two seconds. It proved quite a challenge for the project that the RFID sys-



Niels Bo Theilgaard

tem had to manage one moving object at a time.

"It was a very exciting project, and we have gained a lot of valuable information. We have now initiated a new, revised, confidential project, because we believe we can make further improvements. We are already busy building a new prototype, in which, moreover, we will incorporate wireless technology," Niels Bo Theilgaard explains and continues: "I am convinced that we will succeed. And then we will be holding a very unique new game technology which, by the way, will have a wide range of other uses too!"

GamesOnTrack A/S...

...is owned by NBTI Aps, and the board of GamesOnTrack A/S is constituted of experienced personalities within Danish software, electronics and communication businesses. The company expects to launch its first products within a year.

CISS
– a key player
regionally,
nationally and
internationally

CISS has found the recipe for success

“There is excellent interaction with industry and a good balance between theoretical and practical work. The CISS Initiative is clearly an example of best practice at an international level...”

...The group [CISS] has a remarkably strong record and is a leading force in fundamental research, applied research and knowledge transfer. The research topics also form a nice progression from fundamental studies to application... Overall, this group is internationally leading in all of its core areas of activity. “

So an evaluation committee consisting of Danish and international top researchers wrote in 2006, and the words still stand. Aalborg University as a whole is renowned for its extensive collaboration with industry, as several recent reports and statistics have shown – in fact, both industrial actors and governmental evaluation reports name Aalborg University as the foremost university in Denmark when it comes to collaboration with industry, knowledge transfer – and educating the highest qualified and most wanted engineers in the country. And CISS is a vital ingredient in this.

Meeting business partners on their own turf

Even though Aalborg University does not spend as much money on selling or promoting its research (either in terms of collaboration or in terms of e.g. consultancy services) to business partners, it is still the university



in Denmark responsible for the largest sale of knowledge, consultancy and ideas to industry. The key to this is something that CISS is brilliant at: meeting industrial partners on their own turf. From the very beginning, CISS has focused on working closely together with local, national and international business partners and has sought them out where they feel most at home: out in their own companies or at trade fairs and industrial shows.

Crucial regional role

“It is an absolute necessity for research institutions to get out and do canvassing and be visible, and I think CISS is doing extremely well with their going out in the companies and participating in trade fairs and industrial shows – keep doing that!” Grimur Lund, managing director of Logimatic and chairman of the ICT Forum of Northern Jutland says. He goes on to emphasise CISS’ crucial role in regional development.

“We – the companies located in Northern Jutland – are privileged by having the most high-tech

university in Denmark right here. That gives us an obligation: We need to be the most high-tech region of Denmark. We have easy access to knowledge, not least due to having a centre such as CISS, and at the same time, CISS contributes to strengthening the visibility of the ICT of Northern Jutland and to branding the competences located here,” he says.

Internationally renowned

But CISS does not only work within regional or national borders. The centre employs and has access to a series of world-class – and globally renowned – researchers within the fields of Computer Science and Electronic Systems. Led by Professor Kim Guldstrand Larsen, researchers from CISS participate in scientific activities all over the world, and CISS also plays an important role in a range of co-European research projects and activities. In addition, the centre employs a number of international PhD students and thus also in this way possesses an extensive network of contacts to the world’s most outstanding research institutions.

Facts about CISS

CISS is an ICT centre of excellence under the Danish Agency for Science Technology and Innovation. The centre is located at Aalborg University and is thus rooted in one of Denmark's leading research environments.

The centre is based in the Department of Computer Science and the Department of Electronic Systems and thus have world-class researchers from both departments at its disposal. In addition, CISS employs a large number of PhD students, also from both departments. This gives the centre a unique combination of competences that its business collaborators can benefit from.



The Cassiopeia building

CISS is located in the Cassiopeia building in Aalborg, Denmark, where companies can rent offices and other facilities and thus be close to the researchers during collaboration projects.

Our 11 major research areas are:

- Model-driven development
- Intelligent sensor networks
- Real-time operating systems and platforms
- Security- and safety-critical systems
- Validation and testing
- HW/SW co-design
- Object-oriented analysis and design
- High-level programming language
- Optimum scheduling
- Wireless networks
- IT in automation

Business collaboration

CISS continuously works in close collaboration with industrial partners in terms of research projects, seminars and knowledge transfer. At the moment, we offer the following forms of collaboration:

- CISS 3-year industrial PhD programmes
- CISS VIP – Short-term business-oriented Projects
- Courses – workbased learning
- Student projects

Research projects

Since its establishment, CISS has initiated almost 50 research projects, the majority in collaboration with national as well as international business partners.

For more information, please visit our website

www.ciss.dk

Here, you can also find a complete list of our researchers and PhD students and read more about our major research areas.

Control your computer – using your tongue

One of the severest possible after-effects of a traffic accident is getting a spinal cord injury. In the US, almost a quarter of a million people are paraplegics, while in Denmark the number is 'only' 3,000. About half of these are tetraplegics – which means that they are paralysed from the neck down. These people need assistance for everything.

At SMI, Center for Sensory-Motor Interaction, Aalborg University, Denmark, associate professor, PhD Lotte N. S. Andreasen Struijk is working on a project which will hopefully enable these people to independently access the internet and write e-mails and text messages. CISS plays a vital role in the project, which is colloquially known as 'the tongue project'.

Keyboard and joystick in one

"We use a palatal brace like the one many children have worn if they have had their teeth straightened. Then we apply a

"We are working on a model with 18 sensors, of which 10 will be letters – kind of like on a mobile phone. In addition, we will, among other things, have a mouse-pad area which will also function as a joystick. With time, this may come to be used for controlling a wheelchair as well. Our aim is to embed as many features as possible, so each sensor will contain several functions," she continues.

A matter of size

One of the challenges for the project has been the development of wireless communication and energy supply, and this is where CISS' expertise has come in handy. Henrik Vie Christensen, chief developer and leader of the new CISS VIP initiative (CISS' new 'greenhouse' for development and innovation of products using embedded software), has been working on these challenges. Since the device needs to fit into the user's palate, elements like energy efficiency and size have been great concerns, but these seem to have been solved now, Henrik Vie says. "The electronic systems work, the communication works, and the test software shows us that the signals it produces actually work," he explains and continues:

"We also think we have found someone who will be able to create the batteries we need. It is mostly a matter of size now, both in terms of the electronic circuits and the battery. But we hope to have a prototype ready for testing on intact persons in the autumn of this year."

Unlimited potential

The project group is working closely together with a panel of users consisting of tetraplegic persons and persons with neuromuscular diseases. "This gives us input as to which elements we should prioritise," Lotte N. S. Andreasen Struijk says. "We are all very happy about working on this project, first of all in terms of the potentials – what it may give the users. But we are also happy about our collaboration, with CISS, with TKS A/S (the spin-off company holding the patent for the tongue control system) and with the company Sahva A/S. The collaboration with Sahva has even led to further possibilities; the company has financed a PhD project focusing on the possibility of using our tongue control system for controlling myoelectric arms for people with amputations. So there are almost unlimited possibilities once we get it into production," Lotte N. S. Andreasen Struijk finishes. The group hopes to start manufacturing the system sometime in 2009-2010.



Prototype of the
palatal keyboard

series of sensors which the user will be able to activate using the tongue," Lotte N. S. Andreasen Struijk explains.

Antennas in movement

Reliable communication is a necessity when being on a ship in mid-ocean or in a vehicle in desolate areas. The challenge for antennas situated on such ships and vehicles in movement is keeping a stable connection to the communications satellite to which they are connected – even in high seas or under bad road conditions in which the ship or vehicle is experiencing large movement.

The company SpaceCom A/S in Hobro, Denmark, develops and manufactures antennas for this exact purpose, and over the course of the last three years, they have received a helping hand from CISS through a PhD collaboration project. The specific

succeed in arriving at a practical solution where the antenna would be able to turn out the same level of reliability and precision with two axles as it does now with three, since this would give us a significant reduction of costs – but we probably didn't

ed in creating a solution which enables the antenna to continue working even if one of the axles should fail. "We are continuously working on developing a better and more accurate antenna, so we will definitely utilize his results in our work in years to come," Johannes Christensen continues.



Johannes Christensen, SpaceCom

project that PhD student Seyed Mohsen N. Soltanie worked on concerned moveable tracking antennas. His job was to determine whether it would be possible to spare one of the antenna's three axles by letting artificial intelligence take over part of the mechanical movement of the axle.

Theory sorted out

"At the beginning of the project, we were hoping that we would

quite believe that it was possible. And the project did show that it isn't possible at this point – simply due to a physical limitation in the antenna itself. But Seyed Mohsen N. Soltanie has done an enormous amount of theoretical work that we will be able to utilise in our future work," managing director of SpaceCom, Johannes Christensen, explains.

Among other things, Seyed Mohsen N. Soltanie has succeed-

Happy to collaborate again

And the company is not afraid of initiating another PhD collaboration some day if the right challenge appears. "We are certainly ready to do this again. We have gotten a lot of new knowledge, which means that we will be even better prepared to enter another collaboration. We have become more skilled and wiser, and we will be able to make use of this, both in terms of working out a realistic challenge for the PhD student and in terms of getting an even better collaboration process during the project. It takes both time and energy on a daily basis to get maximum benefit from a project like this," Johannes Christensen emphasises. The company is continuously collaborating with Aalborg University in different ways, so it is probably only a matter of time before another PhD student from CISS can be found within the company premises in Hobro.

Collaboration without boundaries

When it comes to Danish and international collaboration projects, CISS holds a strong position. At the moment, CISS is participating in several projects and applications in relation to EU funding programmes. The international projects open up for collaboration with some of the most outstanding research institutions in Europe – and a series of interesting international



companies. This draws even more attention to CISS, both nationally and internationally, and thus gives CISS the opportunity to cement the centre's position as one of Europe's leading centres within intelligent embedded software. On this and the following pages, CISS presents three of the projects in which the centre is currently participating.

D-Artemis:

Danish companies to be considered by EU funding programme

In 2006, the European Commission initiated the formation of a series of co-European initiatives in the field of technology. One of the first is the ARTEMIS initiative.

ARTEMIS is an initiative whose purpose is to control European research and development within embedded systems, a technology which is gaining increasing importance in many significant business sectors. The budget for the ARTEMIS initiative is expected to be around 3 billion Euros over the course of seven years, of which more than half will stem from industrial partners and the rest from the EU member states and associated nations, as well as from the Commission. "As such, a prerequisite for participating in ARTEMIS

is that the individual states themselves contribute financially. Therefore, we established D-Artemis as a syndicate, and in the spring of 2007 we applied to the Danish Ministry of Science Technology and Innovation for funds to create nationwide awareness of the ARTEMIS programme, so that we can match Danish companies with research institutions and thus be ready for the next step: establishing concrete projects capable of obtaining the necessary funding from the Ministry to be able to participate in ARTEMIS," explains vice director of CISS, associate professor Arne Skou.

Aim: Two major applications

The actors behind the Danish D-Artemis project are the competency clusters DaNES and Pervasive Computing along with CISS, the Alexandra Institute, the University of Southern Denmark, the Technical University of Denmark, the University of Aarhus and DI ITEK, who holds the status of project manager. In addition, seven companies are partici-

pating. "D-Artemis has received just under 270,000 Euros for establishing the structure and the contacts that will hopefully lead to Denmark handing in two major applications under the ARTEMIS programme within the next 18 months," Arne Skou explains and tells that the first information meeting for potentially interested companies has already been held. The aim of the ARTEMIS initiative is to contribute to maintaining Europe's position as the world's leading area within the field of embedded systems. European industry's own investments within embedded systems are estimated to be around 15-20 billion Euros a year. Today, almost half of the 100 largest companies in Europe invest in research within embedded systems, and most of the 25 European companies spending most money on research are dependent on embedded systems for their products and services.

"The Danish government want more Danish companies to participate in EU-funded projects such as ARTEMIS, and therefore it is our hope in D-Artemis that we will be able to get the necessary financial patronage to assert ourselves in the ARTEMIS programme," Arne Skou finishes.

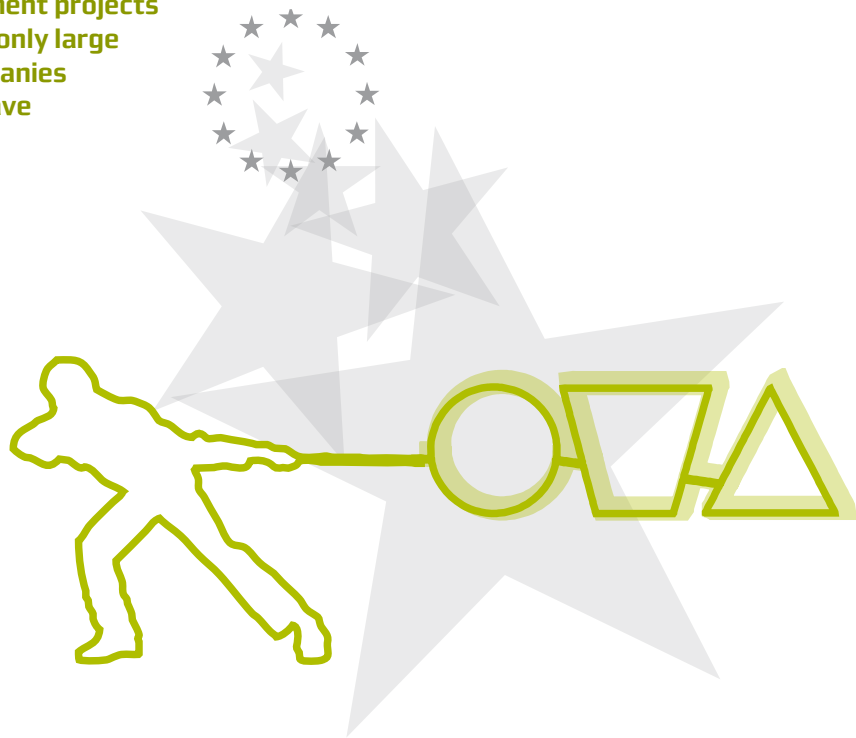
Read more about D-Artemis at: www.d-artemis.dk



MoDES 2:

SMEs get access to the latest research

Many research and development projects are so 'substantial' that it is only large and technology-strong companies who can participate. They have the possibility of allocating resources and employees for projects that may take several years to finish.



But now, CISS is heading a project that will give small and medium-sized enterprises access to the latest knowledge about model-based development – and thus enable them to achieve a significant technological lead.

MoDES 2 is the name of the project, and it is in many ways markedly different from many other CISS projects. “Significantly, the companies that are to participate in Modes 2 have not had any prior contact with CISS. This means that right now we are out there making contact with new small and medium-sized enterprises who might potentially get an advantage from participating in the project,” vice director of CISS, associate professor Arne Skou says.

Coherent methods and tools

As the name indicates, MoDES 2 is standing on the shoulders of an ongoing project, namely MoDES - Model Driven Development of Intelligent Embedded Systems, which runs from 2006 to 2010. The purpose of MoDES is to determine the

potentials for developing a coherent design methodology for intelligent embedded software – with models, techniques and tools to match. A kind of common frame of reference for all the processes in model-based development, which will enable developers to work faster and far more efficiently during the development phase.

“MoDES is funded by The Danish Council for Strategic Research, and they are the ones who have invited MoDES and other ongoing projects to continue our work by seeking collaboration projects with business partners,” Arne Skou explains.

Aiming for two to three projects

CISS has received DKK 0.5 million (app. 67,000 Euros) for the project and is at the moment busy scan-

ning the market for small and medium-sized enterprises who might be interested in becoming better qualified within the field of model-based development. Afterwards, the group behind MoDES will start determining which projects would be realistic to carry through. “It is our aim to initiate two to three projects. And the companies participating in this project have the possibility of getting co-financing for their participation. This makes the project desirable for small companies who would not otherwise have the chance to participate in research and development projects,” Arne Skou points out. CISS is behind MoDES 2 as project manager, and in addition the University of Southern Denmark (the Mads Clausen Institute in Sønderborg) and the Technical University of Denmark (IMM) in Copenhagen participate.

Read more about MoDES 2 at:
www.cs.aau.dk/modes/

Quasimodo:

Boosting European software development

If someone mentions the European Union's 7th Framework Programme, the eyes of most European researchers will start to shine. The programme, which is the largest and longest-running research programme in the history of the EU, gives out more than 50 billion Euros to co-European research projects over the next five years.

One of the projects that have already gotten through the eye of the needle is the Quasimodo project, of which CISS is coordinator and the main driving force. The aim of Quasimodo – the name means Quantitative System Properties in Model-Driven Design of Embedded Systems – is to determine the potential for developing models capable of taking over some of the work related to measuring and experimenting during the development process when designing new software – and thus help save valuable time during the development process. "Our goal is to increase the competitiveness of European companies by the use of models that will enable them to design complex systems in a both faster and cheaper way," associate professor Brian Nielsen, CISS, explains.

Strong international partnership

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. "It is a strong partnership and the best within the field that the project focuses on. And everybody is very committed. We saw proof of this in January this year, when we held the kick-off meeting with more than 30 participants. We experienced a great enthusiasm for the project," Brian Nielsen explains.

Flower stands, pumps and satellites

The Quasimodo project takes its point of departure in three concrete challenges that the three participating companies are currently facing, and the research institutions work across borders in order to find solutions for them. Solutions which are to be converted into more general solutions to the benefit of other companies. "Among other things, we are going to be working with controlling hydraulic pumps, in which for instance electricity consumption



and wear are significant quantities to have under control. We want to minimize both, but unfortunately control with minimized electricity consumption causes too much wear on the machinery and vice versa, so the question is how to find a practical overall optimum?" Brian Nielsen explains and continues:

"Our work within intelligent sensor networks on flower stands has a special relevance for Holland. In an attempt to prevent the disappearance of flower stands, we need to enable the stands to notify each other – and for instance gather information and send it on through a 'super stand'."

In Denmark, Quasimodo is going to be working with software for controlling satellites. "Shortly speaking, the three challenges have the following in common: they are concerned with the analysis, simulation, code generation and testing of models, all of which will eventually be converted for use in practice. Afterwards, trade and industry results will be disseminated to the industry," Brian Nielsen finishes.

Read more about Quasimodo at:
www.quasimodo.aau.dk

From LEGO® to steel production plant

CISS' research within real-time operating systems has resulted in an unexpected side benefit. The calculation methods developed by CISS have turned out to be excellent for scheduling complicated manufacturing processes.

"We discovered that the algorithms and data structures that we have developed for analysing and testing real-time systems are also highly suitable for calculating the most efficient manufacturing process in large production processes," CISS PhD student Jacob Illum Rasmussen says. Scheduling, as this process is called, is concerned with a calculation process that shows how a series of actions need to be carried out to make the overall process as efficient as possible - both in a computer-based system and in the real world. One of the ways in which CISS has transferred these methods to the real world is through a co-European collaboration with the Belgian steel processing plant SIDMAR. CISS was one of a number of European research centres and groups working on the plant's challenge - to optimise the manufacturing process through which the raw iron ore is moved around the plant being processed into a range of different alloys. It was not only a matter of making a number of processes function in a synthesis to keep the plant running smoothly - it was also a matter of finding the most cost-efficient schedule in terms of e.g. power and time consumption.

Challenge solved in LEGO®

"It was quite a challenge for us at the time; we didn't know if we



*The LEGO® model
of the SIDMAR steel
production plant*

were actually able to calculate plans for optimising the plant's production process on such a large scale. But it turned out very successfully!" Managing Director of CISS, Kim Guldstrand Larsen, says. An important tool in this process was UPPAAL, a test and verification tool being developed in a collaboration between Aalborg University and Uppsala University in Sweden. Using the tool for creating a model of the production process and adding certain 'guides' in correspondence with the plant's requirements in terms of for instance cost-reduction enabled the researchers to develop a comprehensive control program for the plant's cranes and processing machines.

This control program was then tested on a model of the plant built in LEGO®. By using this physical model, the researchers could test their scheduling control program for the process in different scenarios and thereby improve and adjust it to function optimally before actually implementing it in the physical plant.

The LEGO® model is now a favoured exhibition object when CISS is exhibiting its research projects - a lasting memento of a successful international collaboration which opened up for new ways of implementing CISS' research within industry.

Kirk  POLYCOM®

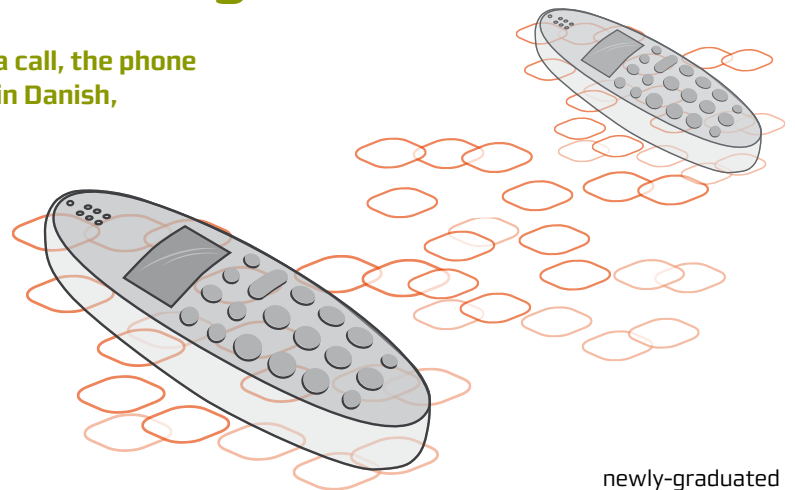
– multilingual programming

In the instant you pick up your phone to make a call, the phone does not care at all whether you are speaking in Danish, English or Urdu. What does matter, however, is the programming language used when developing new wireless phones.

Technical director for Polycom – formerly Kirk Telecom – Erik Stridbæk confirms this. “The systems that we are using need to be as open as possible, and thus quick and easy to adapt. And at the same time, there is a demand for a high level of reliability – there is no margin for error. Back in the days, we used to say “If it’s Kirk, it’s got to work,” Erik Stridbæk explains and continues: “Every platform used in our DECT telephones we have built up ourselves, and they have been programmed using different programming languages. And it is important that all platforms are capable of communicating with each other. If we had been working with a computer, we would probably have chosen an open source platform such as Linux, but since a wireless phone has a very limited ‘hard disk capacity’, Java is without a doubt the safest choice. Therefore, we have very high expectations to the PhD project that Stephan Korsholm is working on at CISS.”

Cannot simply change the language

PhD student Stephan Korsholm himself comes from the former Kirk Telecom, and he says: “With Java, you have the advantage that you discover programming errors earlier than with other programming languages. This means that you don’t need to go as far back in the process



in order to remedy them – and eventually this means a higher level of efficiency. The programming period is shortened accordingly. However, if everything were to be re-programmed using Java, it would take a long time in which the company would not be productive. Thus, in practice, it is almost impossible to re-write all company software in another language. It has to be done gradually.” This challenge he and Polycom have now set out to solve. The aim of Stephan Korsholm’s PhD is to make it possible to use several different development languages simultaneously. This means that

newly-graduated engineers who have worked with Java at the university can use Java for programming, while their experienced colleagues can continue using C or start working with Java. There will be an almost unlimited liberty of choice.

Multilingual programming is a novelty

Stephan Korsholm expects Polycom to convert all its software programming to Java over the course of some years, but thanks to Stephan Korsholm’s PhD project, the company does not need to rush it. And that makes the project rather unique. Because while several companies worldwide have changed their programming language – and have written thick manuals on how to do it – so far no one has managed to use several different programming languages simultaneously. Therefore, it will not only be Polycom who can look forward to the point in two years’ time when Stephan Korsholm has finished his PhD and published his academic articles describing how to use multilingual programming.

Polycom

Kirk Telecom develops, manufactures and markets wireless solutions based on a series of different technologies. The company was bought up by the American company Polycom in 2007. Polycom is one of the world’s leading players on the market for professional wireless communication solutions with an annual turnover at one billion dollars. For more information, please visit www.kirktelecom.com

Turn the power plants up and down

On a liberalised electricity market where both we as customers and Energinet.dk – who are responsible for our security of supply – can purchase electricity wherever we want, it would be to everybody's advantage if it were possible to turn the electricity production on the Danish power plants up and down and thus adapt production to demand.

"In addition, we take great pains to integrate wind power and other alternative kinds of energy, and consequently we invest a lot in improving the power plants' ability to adapt their production to the demand and the fluctuating wind power," head of department at DONG Energy, Tommy Mølbak, points out. But he admits that regulating the production of electricity is not that simple. Associate professor, PhD, Jan Bendtsen from the Department of Electronic Systems at Aalborg University, explains why: "The coal-fired power plants are practically constructed so as to function with a more or less constant level of production. If you want to turn the production up and down, you are faced with some challenges. First of all, it is difficult to regulate the amount of coal entering the power plants, and secondly, fluctuations in the amount of electricity produced may occur," he explains. But a newly-started PhD student at CISS, Pjotr Niemczyk, wants to change that. In collaboration with DONG Energy, he has started trying to clarify how the coal-firing can be regulated with the power plant still managing to deliver a stable amount of power under varying conditions.

A huge potential

"One of the biggest challenges are the fluctuations that the coal mills may cause. So the object is to detect and measure

exactly which controlled variables you are dealing with – and then to control them," Jan Bendtsen explains.

At DONG Energy, the management are pleased with the potentials of the PhD project. "We are operating on a 'just-in-time market', and therefore there is a huge potential in being able to regulate the electricity production, as it will allow us to turn the plants up and down rapidly depending on the demand. This also means that we will be able to provide a better service for Energinet.dk. So all in all it is a very interesting project," Tommy Mølbak firmly states. He continues:

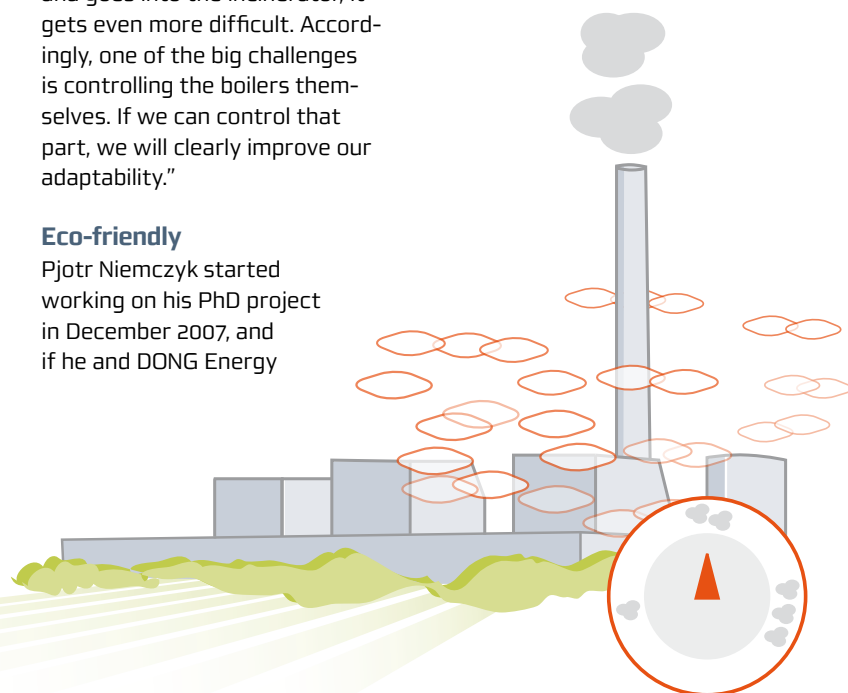
"The coal mills feeding the power plants are difficult to control. We know roughly how much coal is being fed into them – and when the coal gets ground to coal dust and goes into the incinerator, it gets even more difficult. Accordingly, one of the big challenges is controlling the boilers themselves. If we can control that part, we will clearly improve our adaptability."

Eco-friendly

Pjotr Niemczyk started working on his PhD project in December 2007, and if he and DONG Energy

succeed in finding better methods for rapidly turning the production of electricity up and down, there is also an interesting environmental aspect – especially at a time when everyone is talking about global warming. According to Energinet.dk, in 2005 the Danish electricity and CHP sector was responsible for 41 percent of the country's CO₂ emissions while causing 36 percent of the country's total production of sulphur dioxide.

"In addition to being able to incorporate more wind power, there is no doubt that there is a further potential environmental spin-off from the project. In order to ensure as low emissions as possible, we need to have optimal control of the incineration process," Tommy Mølbak points out.



CISS contributes to animal welfare

One of the first business collaborations initiated by CISS took place over the years 2004-2007. CISS collaborated with the Danish company Skov A/S who produces climate control and production monitoring systems for animal production. CISS' representatives in the collaboration were PhD students Jens Alsted Hansen and Jan Jacob Jessen, who were working on a project concerning sensor-driven climate control for pig stables.

Software team leader at Skov A/S Martin Riisgaard-Jensen says: "For a while, we had been convinced that there were technologies and theories out there that neither we nor others in our line of business had taken advantage of, and right at the moment when we seriously decided to plunge into the exploration of new technology, CISS appeared as an industry-focused research centre. The basic idea was to embed the notion of 'good farming practice' into the automated system. Apart from the increasingly large livestock, there is a tendency abroad to employ less and less qualified workers. Therefore, it will benefit the animals, but it will also benefit the farmer, because the animals will grow faster and the quality of the meat will be enhanced."

He is very pleased with the outcome of the project. "I think the collaboration has run smoothly. All our expectations have been fulfilled – and over the course of the next couple of years we will start implementing the technologies which the two PhD students have developed," he says. "I believe that the technologies which Jens and Jan have worked with will contribute to Skov – as the first company within our line of business



Jens Alsted Hansen and Jan Jacob Jessen

– taking the technological leap forward that will happen in any case within our field. And the fact that we are the first to do so will strengthen and expand the lead that we already have in a rapidly growing market. "

Showing the way

"When a company like Skov wants to develop their climate control systems using embedded software, there is a jungle of possible technologies and theories that they can use. What we have done is to show them a way through this jungle; show them a way it can be done," Jan Jacob Jessen explains. The technologies they have worked with concern error detection systems, sensor fusion systems and a controller for the

sensors – technologies which can be used to create a more reliable and sturdy climate sensor system.

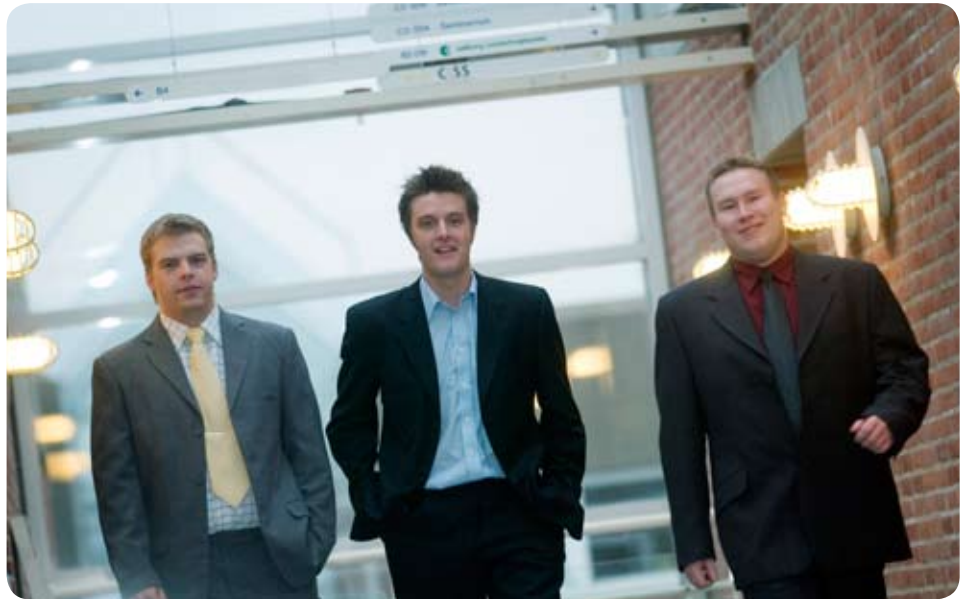
The two PhD students themselves have also gained valuable knowledge from the collaboration. "There was a continuous, valuable knowledge transfer both ways," Jens Alsted Hansen says, and Jan Jacob Jessen agrees. "We gained insight into how a company such as Skov functions – the reality out in the companies is often quite different from the one we experience at the university. They are facing different challenges that need to be taken into account during product development. We have been able to use this knowledge in our later work," he finishes.



World-class students

It is not only the researchers at CISS who are world-class – so are the students. International companies and organisations have several times recognised the quality of the students' work, already before their graduation.

One example of this is the Umbrella Project – a project by three master students studying under CISS. Their project concerned creating a programme to protect internet-based and –related communication devices – such as mobile phones – from virus and hacker attacks. Soon after the initialisation of the project, the Danish telephone company TDC heard of it and realised its potentials. Therefore, they offered to co-finance the students' work, and in return the students focused their project on TDC's work with internet-based alarm units.



Kristian Sørensen, Søren Nøhr Christensen and Michel Thryssøe

May save lives

"Internet-based alarms require a multi-channel internet connection, allowing the alarm to have its own channel. We are working on this, but in order to make sure that no one can access our system through the alarm units or that outsiders can deactivate the alarm units, we have joined The Umbrella Project. In the end, operational reliability in this field may be a matter of human lives, so we need to put up so many defences that no one can break through," information systems consultant Frank Larsen, TDC, explains.

Reverse logic

In order to achieve the necessary level of security, the three students started from the end, so to speak. "Today, most systems describe what the specific applications or the individual user

should be able to access. We start out by defining what they should not be able to access. In this way, we create a safety shell around the programme, and at the same time it saves us a lot of work. The number of 'no-go' areas is far smaller than the other kind," Kristian Sørensen, one of the three students behind The Umbrella Project, says.

The American Adventure

The project attracted attention not only from the Danish company but also from a range of global companies working within mobile technology. Through a contact at Panasonic, the students received an invitation for a workshop in a security work group under the Consumer Electronics Linux Forum – a meeting which was held in New York, and

at which companies such as Sony, Phillips, IBM and Samsung were represented along with Panasonic itself.

During the workshop, the students got the chance to relate their results and research, and they experienced a highly professional but also open atmosphere. "It was an extremely competent group representing an amazingly wide range of products, but they would listen when we were talking, and our comments and objections can be read in the report from the workshop," Kristian Sørensen says.

As a result of their trip, the contact to Panasonic was strengthened and formalized, and the students also received an invitation from IBM Research to come to Tokyo and work for them for some months.

CISS builds bridges between
research and industry

CISS understands
industrial working conditions

CISS possesses
unique competences

Embedded software
- a growth industry

Centre for Embedded
Software Systems

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