PEN speaks to leaders from the **ARTEMIS** Industry Association Steering Board, about how research into embedded and cyber physical systems can help Europe maintain its position as a global leader

The systems of the future

AT the ARTEMIS spring event in Brussels on 14 March, Pan European Networks met with Professor Heinrich Daembkes, president of the ARTEMIS Industry Association Steering Board, ARTEMIS secretary general, Dr Jan Lohstroh, and Mr Ad ten Berg, the ARTEMIS office director, to ask them about the role that embedded systems will have to play in Europe's future.

Established in 2004, the ARTEMIS European Technology Platform (ETP) was designed to bring together key players in the embedded computing arena across the entire spectrum of industrial sectors by five major companies. One of its core tasks was to define a common Strategic Research Agenda, which acts as a reference for the embedded computing domain to attract investment from the stakeholders. The first version of the SRA was published in March 2006, covering the entire needs and challenges of this technology domain.

The ARTEMIS Joint Undertaking was established in February 2008 as a community body based in Brussels by means of a council regulation. The ARTEMIS JU will implement significant parts of the SRA co-funded by industry, research organisations, participating member states and the Commission's own ICT programme. The ARTEMIS JU will manage and co-ordinate research activities through open calls for proposals.

ARTEMIS is thus focused on the research and development of embedded systems and, moving forward, of cyber-physical systems, therefore improving Europe's competitiveness.

"Embedded systems," explained Daembkes, "can be described as the combination of hardware and software inside a system, and ARTEMIS is primarily concerned with the software elements. Embedded systems exist in many applications, from a digital watch to a smartphone to the control system of a heating system, the cockpit of an aircraft, cars and medical systems. Thus, without embedded systems, no modern car would function, no plane would fly, and no factory would work, as embedded systems are integral to process automation.

"From the realm of mobile communication, a new combination of traditional systems with those concerned with communication is now emerging, which is known as cyber physical systems. This would not be possible without the inclusion of embedded systems, and this area will thus form a future focus for both ARTEMIS and the wider embedded systems community."

Strength

The field of both embedded and cyber physical systems are thus integral to Europe's future. ARTEMIS has been working for some time to ensure that Europe remains in a relative position of strength in order to continue developing future generations of embedded and cyber physical systems by establishing a community of players and actors in the field of embedded systems

Professor Heinrich Daembkes

Dr Jan Lohstroh

Ad ten Berg

"That was Phase One," Daembkes said. "This was fundamental, as it was of the utmost importance to begin to create some form of synergy to what was, at that stage, an extremely non-harmonised world. Now that this has been achieved, we have begun to work on focusing our industrial and research activities towards those areas in which we feel Europe has a significant strength advantage versus its competitors."

Jan Lohstroh added: "Indeed, from our research agenda we discovered that there were not enough funding programmes in Europe, and that more activity was needed to keep Europe at a competitive level. We therefore approached the European Commission with that idea, and the ARTEMIS Joint Undertaking emerged.

"Thus," he continued, "related to the ARTEMIS brandname, there are two legal entities – the ARTEMIS Industry Association (ARTEMIS-IA) that emerged from the ARTEMIS ETP, and the Artemis JU, whereby we formed a public-private partnership, in which ARTEMIS-IA acts as the private partner and working with the Commission and member states to define the programmes which are funded.

"The ARTEMIS IA contains three groupings: they cover the entire food chain, right from the research activities taking place in universities and research and technology organisations – which are members of our industrial associations, and are delivering the fundamentals, the new elements, and the creativity."

"Then," explained Daembkes, "we have a chamber for the SMEs, because, particularly in our market segment and technology domain, it is expected that these enterprises are faster at delivering results. However in reality, only a

certain fraction of the SMEs are able to do that, the rest are fully loaded with the demands of daily business.

"The third element is the association of large industry, which has the money, the strategy and the breath to conduct research over a number of years and to bring new systems into the marketplace."

Eureka moments

Joint undertaking structures in Europe have worked quite well in the past, and PEN asked Daembkes whether he felt that changes were needed in the shape and arrangements of these structures. He answered: "Joint undertakings were borne out of the experience gained from the Eureka programmes. Here, there was an issue with how funding was hindered across borders and with the input of individual member states.

"Due to the difficulties to harmonise the efforts between the member states, the Eureka programmes sometimes saw some partners nearing the completion of their projects, while others could not begin because funding had not been released. The intention was thus to create an enhanced synergy, whereby the EU could contribute and act in a harmonising manner. These issues were, indeed, the fundamental ideas behind forming the ARTEMIS joint undertaking."

Ad ten Berg added: "In a next step, the new idea from the Commission is to bring the three existing ETPs for Nanoelectronics (ENIAC), Embedded Sytems (ARTEMIS), and Smart Systems (EPoSS) together in one new organisation. The first new call will start 2014, meaning that there will be the three initiatives in one joint undertaking.

"We are in constant contact with the Commission and member states about this new structure, and are working very hard to help in the formulation of this new organisation. There are changes in the air, but the concept has been proven in the first phase."

Daembkes expanded: "The next phase will involve a stronger alignment between the existing joint undertakings. A large part of the constituency of each of these entities is identical, therefore there is a good chance to obtain the required synergy by this close co-operation."

"For instance, embedded systems rely on advanced microelectronics and nanoelectronics. Without them no embedded system is possible. And vice versa, nanoelectronics are significantly driven in their use and applications by embedded systems."

One of the main roles of ARTEMIS involves preparing the necessary technology to enable future applications. This technology will come to be increasingly used in areas as diverse as the Internet of Things – an entity using technology based on embedded systems – as well as in the energy sector, where embedded systems are integral to smart distribution and smart grids, and in the newly emerging E-cars and so on, which will all use and be based on embedded systems (among other things, of course, such as new drives, new energy conversion and storage principles, for instance) – but the core, the network inside, will include embedded systems.

"Therefore," Daembkes highlighted, "we must have multiple avenues to explore in order to prepare for the future."

Horizon 2020

The idea of preparing for the future ties in well with the priorities of the European Commission's next framework programme, Horizon 2020, which has placed a significant emphasis on addressing the grand societal challenges facing Europe and, given the integration of embedded systems into such a variety of applications, it is not surprising that this sector will also have a role to play in this sense.

Daembkes advised: "Technology, and so embedded systems, is fundamental to the approaches that must be explored in relation to how Europe will react to societal challenges, such as the trend towards urbanisation, intelligent mobility, the scarcity of resources, or energy efficiency, for example. In all of these areas, smart systems, embedded systems, and netted systems, play a core role.

"Traditionally, we have been working within a given system, so, for instance, inside a car or tram or plane or industrial automation system. We have been, and continue to be, very busy in developing embedded systems that can be used to control the overall system, and now, these control electronics elements, these embedded systems, are getting smarter; they are able to communicate to each other, and they are also able to gather large amounts of information from the environment."

Reliability

These cyber physical systems are thus able to communicate with infrastructure, or, for instance, a heart pacemaker can monitor environmental stress and changing conditions. Each individual system that is able to communicate with the outside world is therefore generating more value, and creating something new out of these communication capabilities is the next step for us.

However, as Daembkes underlined, reliability is a key issue as: "If you want to rely on such information, then you need to be sure that it is reliable – to take the cyber physical systems that could be used in an aircraft, as an example, if a plane is flying from A to B, in future, a 4D trajectory will be used, using both the 3D space and a time stamp, which is created at each leg of the journey to ensure that only one aircraft is in one area at a given time. Thus, during the flight the aircraft needs to communicate with its environment, and it is of paramount importance that this communication is of the highest quality.

"Quality of service will be something that will therefore concern us in the future so that we can develop reliable services for safety critical applications."

Lab to market

A further focus of Horizon 2020 is to decrease the time that it takes to develop a product or application and get it to the marketplace. This is also an area that ARTEMIS has begun to explore, as office director ten Berg explained: "We have tried to group our organisations into centres of innovation excellence that work together in order to speed up the time it takes for research outcomes to reach the market. Moreover, the ARTEMIS Innovation Projects (AIPPs) are large projects that focus on innovation more so than research, meaning that they are also trying to have a bigger impact on the market."

Daembkes continued by highlighting how, during the execution of the first phase of ARTEMIS, it was recognised that, due to the available instruments, the focus was essentially on the research and early development aspects, thus making it difficult to bring innovations to market.

"Innovation, of course," he added, "means invention plus introduction into application, and recently we have developed a new instrument called IPP, Innovation Pilot Projects, which is helping us to overcome this so called 'valley of death'."

Alongside developing strategies and instruments to speed up the lab-to-market process, a strong co-operative relationship between industry and academia is crucial.

Daembkes explained: "At the science level – which also includes the work that is being undertaken at universities – the research teams are bringing new ideas up to technology readiness level three, or thereabouts. This is using the 1-9 scale, where 1 is discovery, and 9 means is full deployment, and so 3 is where the proof is being done in a lab, 6 is the demonstrator level, and 7, 8, 9 involves bringing it into application.

"The science partners are thus in the lower part of the tier, but the ideas are then picked up by industry in order to bring it into application. It is, nevertheless, important for researchers to get feedback on the real needs of industry, because this, in some instances, can be missing. In our projects, we therefore have a very close working relationship between the two areas."

He continued: "The networks that we have established in recent years has, indeed, enabled us to established a very fruitful environment of co-operation, whereby research organisations are directing their activities to practically usable applications. Nevertheless, we also need to be sure that industry, at least in these IPPs, has the lead, and that we are not just following academic interest.

"It is similarly important that standardised approaches are developed, as these new technologies – computers, smartphones, communication technologies – only work if there are transnational standards."

Competition

While there is little doubt that reducing the time of lab-to-market will help to bolter Europe's competitiveness in the field of embedded systems (and, indeed, technology more generally), many emerging economies across the globe are now beginning to catch up to the stage reached by the developed world.

PEN asked Professor Daembkes whether he felt these economies posed a threat to Europe's

future leadership. He replied: "We are not threatened by global competition, although a series of interesting challenges no doubt lie ahead – and competition, of course, is a positive thing, as it serves to stimulate creativity and activity.

"In some regions, our competitors have quickly caught up. In Korea, for example, particularly in the field of mobile communications and smartphones, TVs and computers, and the increased prominence of companies such as Samsung, what is happening there is really very admirable.

"This is also the case in the USA, particularly with regard to Apple, and many traditional companies are now struggling to re-gain speed in order to stabilise their position in the market."

"However," Daembkes added, "in areas like the automotive industry, production facilities and aircraft industries, Europe is in very good shape. This is also the case in some significant sectors of software industry, and this is no longer just with regard to embedded systems, but also in large systems where software plays a significant role.

"This is certainly an area where we foresee a very good chance for the introduction of our embedded systems into advanced applications. These include, for instance, energy distribution systems, new energy generation systems, energy saving and environmental control systems and even into the control systems used in food production. Indeed, in this latter sector Europe is already ahead of many other countries."

And the professor continued: "Regarding South America, there are very few sectors in this region that are now catching up with Europe. In Brazil, for example, the market is catching up, but at the moment they are focusing on certain specific domains – for instance the aircraft industry that they now need to master as well other new emerging technologies.

"Some of these economies are definitely serious contenders, but they are also partners, and we are working together with them to drive the field of embedded systems forward, and so, not least for this reason, we are challenged by them."

Innovation

PEN then asked for views on whether a greater emphasis should be placed in innovation, as well as research and development, or whether one begets the other?

Ten Berg answered: "In Europe, innovation is not as strong or as developed as either research or development, and, in Horizon 2020, we like very much the greater emphasis placed on innovation, at least in comparison to FP7.

"To gain this focus can be something of a challenge, but even the combination of known technologies into applications can be extremely innovative, and this must be supported in order to make Europe a success."

Daembkes added: "That is a very important point, and the abbreviation 'RDI', rather than just 'R&D', will undoubtedly come to appear more and more.

"The idea of an increased emphasis on innovation is inextricably linked to the way in which Europe must begin to tackle the grand societal challenges. That is, the position of Europe on the global stage with regards to its technological prowess must be maintained if it is not to lose momentum in the face of its competitors. While this may seem to be something of an obvious point to make, there is sometimes the sense that innovation only becomes a focus when competition is fierce and there is a threat of being overtaken."

Indeed, there is a distinct sense that this must not be the case; Europe needs to stay ahead, needs to prepare for the future and, moreover, must be aware of its competitors who are continuing to invest significant amounts of money in pushing forward the boundaries of technology.

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