BUSINESS IMPACT & METRICS

Proof of the successes in the ARTEMIS Programme

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Opening words

In recent years the ARTEMIS JU has provided the framework for the biggest R&D programmes on software-based systems in Europe, stimulating significant new developments in nearly all domains relevant to society. Hundreds of millions of euros' worth of effort has been invested by partners from national R&D budgets, from European sources, and especially from industry and its partners in the research community. This concerted effort is geared towards achieving clear progress in the domains considered to be critical for the competitiveness of European industry and for society as a whole.

In 2010 ARTEMIS-IA decided to monitor its progress via dedicated Working Groups, also providing the foundation for continuous improvements. Despite all the difficulties in measuring the success of R&D projects in progress, the working group created a significant improved base to measure the achievements. Thanks to the dedicated engagement of many volunteers, many individuals and institutions affected by the ARTEMIS projects, their feedback and impressions provide a representative overview of the success achieved and prospects for improvement for the road ahead…

I would like to thank the Working Group for all their efforts and hope that you as reader of the report get a good impression of what was achieved.

Jan Lohstroh, Secretary General
on behalf of the entire ARTEMIS Industry Association

Introduction

The Working Group (WG) 'Metrics and Success Criteria for ARTEMIS' was created in 2010 to define and monitor the achievements of the ARTEMIS JU Programme from a bottom-up perspective, in particular, to generate data on perceived project outcomes directly from the organisations involved in these projects. The goal is to transfer this operational data into a programme-level strategic component such that one can see how project results lead to a more competitive European Embedded Systems Industry.

In 2010, the first questionnaire was only sent to a limited number of consortia for two reasons:

- It could only be sent to projects of Call-1, which were in their second year of operation at the time of the questionnaire
- It was considered a pilot study also aimed at improving the questionnaire, e.g., with regard to its relevance for future applications.

In 2012, we launched a second survey, broadened the scope and reduced the number of open questions to improve ease of use and to obtain more relevant data.

In 2014, we launched the survey a third time. Some minor changes were made to further fine-tune the questions and focus on the data most relevant for improving the programme. In addition, we also conducted some specific interviews on the business impact of ARTEMIS projects, which have been finalised in the meantime.

We consider this third round a true success, as you will see in this report. The goal to measure the success of the ARTEMIS programme and to define steps on how to further improve and prioritise the programme.

Patrick Pype,
Chairman WG Metrics

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Methodology

The 2010 questionnaire was sent to 7 project consortia and we had answers from 34 organisations. This questionnaire could be considered as a pilot case to test out the value of this type of bottom-up questionnaire. As this was successful, it was decided to perform the questionnaire again every second year. In 2012, it was sent to around 800 partners and the amount of respondents varied between 120 and 170 answers. A number of respondents did not complete the questionnaire, but filled in only part of it.

In 2014 it was sent to around 1100 partners and the amount of respondents varied between 130 and 190. In contrast to 2012, this was not due to answering only the first part of the questions, but it varied on a question per question basis.

So the average amount of answers in both 2012 and 2014 amounted to around 150 for each question.

The questionnaire of 2014 spanned the period 19 September till 3 November (six weeks).

We again focused on the three main sub-themes of the ARTEMIS programme:

- Theme 1 : Focusing on common R&D agendas more effectively
- Theme 2 : Providing significant economic and societal benefits
- Theme 3 : Successful results in the market

In total we reduced the amount of questions from 50 in 2012 to 41 in 2014: 37 multiple-choice and four open questions in order to have additional qualitative clarifications to other questions. The further reduction of questions was for two reasons: firstly, as many people did not complete the questionnaire in 2012, we decided to reduce it further and secondly, we agreed that the relevance of some of the questions was not always clear or that some questions had more to do with future projections instead of evaluation of past results. As the questionnaire is intended to evaluate the outcome of projects that are finished or almost finished, we therefore focused on the questions that get results on the past instead of trying to predict the future.

So we hope that this report provides an interesting read and if you have any questions related to it, please contact the office of the ARTEMIS Industry Association: info@artemis-ia.eu.

Executive Summary

This report is the third such report. In 2010 a first questionnaire was sent around to a limited number of participants in the ARTEMIS programme. In 2012 and 2014 we had a much wider number of ARTEMIS participants to tap. For the latest round, we sent the questionnaire around to slightly more than 1100 participants and received feedback from around 150 participants.

The report is again divided into three sections, covering the following themes

- **I** Focusing on common R&D agendas more efficiently
- **II** Providing significant economic & social benefits
- **III** Successful results in the market
- **IV** Business Impact

The main results from the questionnaire on these themes are the following:

- **I** Collaboration within the ARTEMIS Program remains very successful and in the same order of magnitude as in 2012. This also includes the creation of new partnerships. In terms of number of participations, SME involvement in these new partnerships had grown to 70% in 2014 (from 50% in 2012 and 33% in 2010). The partnerships are mainly based along the technology axis and this is even more explicit than in 2012. The level of interaction with a CoIE (Centre of innovation Excellence) has become less popular than in 2012 (from 31% to 23%). This is probably due to the fact that the CoIE concept was quite new in 2012 and a few CoIE started in 2012. So we were in a start-up phase and have now reached some level of maturity. However, the creation of new CoIEs has lost some momentum. Therefore it is probably worthwhile to set up some new promotion and marketing around CoIE. The main motivator to work in ARTEMIS remains for the third time the industry-driven approach. The impact on the R&D agenda remains the topic of 'having increased knowledge and experience thanks to participating in ARTEMIS projects'. Concerning the consideration of alternative funding schemes instead of ARTEMIS, the funding through national/regional programmes has climbed to the 1st position (FP7 and ITEA are 2nd and 3rd position). As a key strength, the topic 'industry-driven/industry-relevance' is again top. As key items for attention, we see 'uncertainty about availability of funding for all partners' and 'administrative' burden. They both remain at the same level, so no improvement was visible. In 3rd position for attention is the 'poor alignment of EU and local authorities', which was 6th in 2012. Some food for thought…

II ARTEMIS addresses a wide range of technology and application markets. From an application point of view, automotive remains the main market addressed. The market impact mainly concerns a period of three to five years after the end of the project and shows similar results compared to 2012. Business impact is mainly on reduced development costs and reduced time-to-market as was also the case in 2012. The realisation of 'new products' moved however from 6th position in 2012 to 3rd in 2014, at the cost of 'higher re-usability of components' (moved to 4th). All ARTEMIS AWP targets are addressed and results are similar compared to 2012 and 2010. In terms of societal challenges, the top-3 remains the same as in 2012: 'security & safety', 'transport and mobility' and 'energy efficiency'. The impact on 'Future Factories' has increased considerably and now shares 4th position with 'Health & Well-being' (from 7th in 2012).

III The development of prototypes and demonstrators remains a key activity in the ARTEMIS programme. The number of partners developing prototypes and demonstrators is growing, from both an application and a design tool perspective. Tool usage is 83% within the consortium and 17% outside the own consortium, which is in the same order of magnitude as in 2012. 19% plan to contribute to the ARTEMIS tool platform (compared to 29% in 2012), but 47% (compared to 43% in 2014) does not yet know what this platform is – this remains an item for attention. The impact of the tools remains the same as in 2012, with the same two items top: 'reduction in development time' and 'improvement in product reliability'. The contribution to standards has declined further to 37% (compared to 47% in 2012 and 67% in 2010). Most emphasis is on the extension of existing standards and enhanced participation in regular standardisation committees. The positive aspect is that the activities in 'standardisation' are not 'business as usual', but include a higher level of activity in 2014 for those who contribute to standardisation. So although the quantity has decreased, the quality of the work has increased. 53% of the respondents plan to contribute to an Open-Source Community (including the creation of a new OSC), which is approximately the same as in 2012. 40% of the respondents plan to set up public trials or field tests, which is at the same level as in 2012. The AIPPs remain the ideal platform to provide the scope and means to realise this on a larger and more professional scale. 55% of the respondents plan to contribute to educational programmes – this includes a large part of the industrial partners in the programme. This is a slight increase compared to 2012. The amount of patents is slightly lower in 2014 compared to 2012, but with only a very minor deviation. In terms of dissemination, the publication of books and papers, and the amount of presentations in seminars and workshops has grown compared to 2012, while the amount of press releases has decreased slightly.

IV In terms of Business Impact, we have approached projects from the first two calls that have finished and therefore have a better view of the business impact forthcoming from their research: the interview method was selected to retrieve the information as it was expected to be very diverse. And, indeed, where CESAR has a very wide and fundamental impact, for example on standardisation and methodology, others such as the SYSMODEL project were very focused and had very specific and concrete impact on the SMEs in the project in learning to use and embed new design methodology in their own business. Also unforeseen business impacts were observed in projects, a nice example being SHIELD, where the results were unexpectedly applied in the Smart Grid domain. Other projects, such as Pollux and IoE, address new markets with completely new dynamics while Chiron and High Profile address the medical domain, where integration in the diagnostics and cure processes is one of the main keywords. DEMANES addresses the run-time adaptability of networks and system configuration in different domains, enabling systems to adapt more easily to changing environments. Also here concrete cases are presented. Of course, this is just the beginning and we expect to see more of such experiences with project results as more ARTEMIS complete in the coming years.

As an overall conclusion, we can state that ARTEMIS remains alive and kicking! The original aims have been achieved to a large extent and have led to successful results, in terms of technological developments, competitive advantages and market successes.

Overall the Embedded Systems community has found its place in Europe: people are getting to know each other better, a strong link between industry and education has become visible and the quality of the technology and dissemination results is clearly visible from the results of this questionnaire. Taking into account the evolution within Europe of bringing together the ENIAC, ARTEMIS and EPOSS programs into one ECSEL program, one can state that ARTEMIS has definitely shown itself to be a complementary domain of expertise within the total scope of the programme, more in particular in the domain of Cyber-Physical Systems. Therefore, it is important that this field of Embedded and Cyber-Physical Systems forms a separate part in the total ECSEL agenda. In the application domains, one can look into commonalities, synergies and complementarities throughout the complete value chain (from micro-electronics devices to fully integrated hardware/software Cyber-Physical Systems).

Only some of the administrative burden and the alignment between European and Country-Specific Public Authorities remains an issue to be solved…

In-depth project results

In this third issue of the Metrics report, the business impact of projects is addressed more specifically and in more detail than in the previous two issues. This now becomes possible since the first ARTEMIS projects that started in 2009 and 2010 are finished; their results are known and have been brought further to the business by the organisations involved in these projects. In this chapter 2, we interviewed a set of projects on a voluntary basis. We chose the interview method to be able to capture the wide diversity of the projects' business impact, which would not have been possible simply by answering a questionnaire. We hope to show the diversity of impact on the business created by the different projects. Also for the future we hope to follow the results of the finished projects to collect more evidence of the impact of the ARTEMIS programme. We hope that in future more projects will strive to make their business impact visible to create a clear message about the impact of research in Embedded Systems on the competitiveness of Europe.

1.1 CESAR

CESAR (Mar 2009 - June 2012)/ Partners: 53 – 4 Domains/ Total Eligible Costs: 54.92

Challenge

The main challenge taken up by the CESAR project was to reduce the time, and thereby the cost, of development by some 30% by improving the tools and methods for requirements and system engineering. However, the introduction of an open Reference Technology Platform (RTP) for tool interoperability prompted a further challenge: to change the mind-set of tool suppliers, tool users and design methodology research, in which industry orchestrates the direction.

Achievements

To achieve these goals implied the creation of more mature design processes able to accommodate large design teams distributed over many sites and combining many different fields of expertise. It was the cross-domain research in the project that made unexpected results possible and gave a strong boost to systems and requirements engineering, which had not been anticipated initially. The concentration of all engineering disciplines of the design phases in one project also delivered many learning experiences.

An important achievement was the anchoring of competences for systems engineering and functional safety within the companies' organisations (dedicated teams created or strengthened with new employees).

For example, in AVL, the world's largest independent company for the development of internal combustion engine powertrain systems and instrumentation and test systems, the safety research team was transformed from a research department into an industrial department with its own external trade mark (AVL). The fact that this transition occurred among other companies in similar ways shows the usefulness and applicability of the results achieved. The SME partners in CESAR also created or extended existing products based on the results of the project. The experience gained and the results achieved in CESAR have been published in the book 'CESAR-Cost- efficient Methods and Processes for Safety-relevant Embedded Systems" (**ISBN-13:** 978-3709113868).

The extent of the interest in this project paved the way for the standardisation of tool interoperability. In this context, cooperation with existing standardisation bodies or working groups such as the OSLC (Open Service for Lifecycle Collaboration) were established and a new annual conference on interoperability was initiated.

From a partner point of view, this work was an important enabler for the development of related core technologies such as the AVL Open Development Platform, Fraunhofer ModelBus or Dassault Systèmes Enovia. Within AVL, CESAR led to the introduction of an open development platform that is now extensively used along with the establishment of two new departments for systems engineering, system safety and for the implementation of the open development platform.

Furthermore, from a management point of view, the CESAR Process 4 Exchange has been established to enable continuous improvement of engineering disciplines and tool interoperability. This process targets the efficient exchange of information with other research initiatives, thus ensuring that the follow-up projects can build on technical outcomes achieved so far. Process 4 Exchange has already been implemented in many other ARTEMIS projects as has the way in which the technical progress was measured in CESAR.

Business impact

The business impact that CESAR has had can be described as both wide and penetrative. Improved product maturity and the ability to manage a more complex system design enable a greater degree of sustainable market competitiveness while internal exploitation has benefited from better development processes with an improved capacity to handle complexity. The results of the CESAR project have made a significant contribution to the handling of large teams and the cooperation between many different institutes and experts from a range of domains geared to working jointly towards the same target with one system. Furthermore, in targeting the creation of safer and more reliable products, the design methodology applied within the project has led to greater product safety and has provided a comprehensively dependable system.

An undeniably major impact on the European market in the long term is the success of CESAR in laying the foundation for topics that were expanded in ten follow-up projects. The definition of these projects has been strongly influenced by the CESAR project, and specific technical outcomes from CESAR have been taken over and further developed in these initiatives.

Table 10.2 M18 – projects building on CESAR results

Acronym	Phase	Total investment	Coordinator
MBAT (ARTEMIS)	Running	MEUR 34.5	Daimler
pSAFECER (ARTEMIS)	Running	MEUR 10.5	Volvo
nSAFECER (ARTEMIS)	Running	MEUR 16.3	Volvo
VETESS (ARTEMIS)	Running	MEUR 19	Infineon UK
iFEST (ARTEMIS)	Running	MEUR 16	ABB Norway
CRYSTAL (ARTEMIS)	Proposal	>MEUR 70	AVL List GmbH
SPES 2020XT (National German)	Running	MEUR 25	TU Munich
ARAMiS (National German)	Running	MEUR 37	KIT
OpenCOSS (FP7)	Running	MEUR 11.7	Tecnalia
SAFE (ITEA 2)	Running	MEUR 14	Continental

In conclusion, the importance of large projects such as CESAR to achieving and setting standards cannot be understated. The know-how transfer between the different application domains was a key success factor to consolidate the different engineering disciplines according to the respective needs and experience. At the same time, an important lesson that has been learned from the experience of the CESAR project is that maximum impact can best be derived if the focus is limited to fewer research topics.

1.2 SYSMODEL

SYSMODEL (Jan. 2009 - Dec. 2011)
Interview with Ivan Ring Nielsen, Technoconsult ApS

Challenge

Industry is facing a crisis in the design of complex hardware/software systems. Increasing complexity is causing a rapid widening of the gap between the generation of a product idea and the realisation of a working system. So to manage that complexity and to shorten design cycles, industry is being forced to look at system-level languages towards specification and design. The challenge taken up by SYSMODEL was to enable SMEs to build cost-efficient ambient intelligence systems with optimum performance, high confidence, reduced time to market and faster deployment.

Achievement

In order to support the competitiveness of small and medium-sized enterprises (SMEs), six Nordic SMEs teamed up with three recognised R&D providers in the ARTEMIS SYSMODEL project to develop system-level modelling tools aimed at increasing their design productivity. The focus was on developing modelling concepts, methods and tools that master system complexity in an Open Source approach, with all tools available free of charge. The dissemination of the modelling methodologies and tools to a wider group of SMEs was facilitated by a wiki-based entry to tools, models, libraries and tutorials guiding new users through modelling exercises.

Additional training was organised through hands-on workshops where each SME worked on modelling their own prototype, supported by the R&D partners. For the development drive it was also important to clearly define objectives for each SME early in the project and to follow up these objectives with success criteria by means of clearly measurable and visible productivity gains. During the first eight months of the project each SME individually defined its productivity measures by means of markers like time-to-market, code size, system size, defect density, development effort, re-usability and maintainability. In summary, the open source system level tools and methodologies developed by SYSMODEL and taken on board by the SME partners led to significant productivity increases and commercial benefit.

Business Impact

Two of the project's SMEs have commercially incorporated the project's tools and methodologies. Novelda AS, an innovative Norwegian fabless semiconductor company specialising in nanoscale wireless low-power technology for ultra-high resolution impulse radars, applied the SYSMODEL tools to model parts of its next generation UWB radio system. The modelling enables the company to evaluate potential system architectures and tweak important parameters while the design is still at a conceptual level. Novelda's CTO, Dag T. Wisland, explained that this development step would have taken much longer using existing design methods and, even more importantly, the modelling reduces the risk of costly re-spins. It is safe to say that the methodologies provided by SYSMODEL have significantly improved Novelda's productivity and helped it recently win the prestigious Frost & Sullivan 'European Sensors New Product Innovation Award'.

Another tangible impact of the SYSMODEL results comes in the shape of Catena Wireless Electronics AB, a Swedish SME providing Systems-on-Chip developments including architectural choices, circuit design, embedded software development and contract research. Mats Carlsson, Operations

Manager at Catena Wireless Electronics, explained that at the start of a typical project they assist customers in translating their system requirements into a suitable IC architecture with agreed target specifications. After that process they take care of the design, layout and validation of the integrated circuit. At the beginning of this process it is crucial to describe and model at system level the performance of the final product. For this the company applied the SYSMODEL methodologies into one of its developments, where the complexity of integrating hardware and software requires a new tools approach: the SYSMODEL 'Synchronous MoC' and the 'Continuous Time MoC' to verify the systems performance with respect to the requirements. These two system-level modelling possibilities offer new ways to model hardware and software together, which is crucial for reducing time to market and increasing the chance of first-time-right designs.

Finally, the ForSyDe framework significantly profited from the development and testing in SYSMODEL, with ForSyDe-SystemC modelling libraries proving valuable for other European projects: iFest (Artemis) , CONTREX (FP7) and EMC2 (Artemis). Thus SYSMODEL had a huge impact in the development of ForSyDe, which is gaining more and more acceptance in both academia and industry, and the work of Novelda, DA Design and AuditData is documented in papers published after the completion of the project.

By increasing the level of innovation in SMEs over the whole design innovation cycle, SYSMODEL will stimulate sustainable economic growth.

1.3 SHIELD

By Josef Noll | Movation, Norway
Project: SHIELD (pSHIELD Jun 2010 - May 2011 & nSHIELD Sep 2011 - Dec 2014)

Challenge

European industries need measurable security, privacy and dependability (SPD), risk assessment of security critical products, and configurable and composable security. The business-based starting point for SHIELD focused on the impact of embedded systems in the years ahead and the security requirements expected from these Internet of Things systems.

Achievement

The core SHIELD platform is a middleware, prototypes, metrics and validation approach. The SHIELD methodology enables a business to significantly improve the SPD quality of embedded systems while addressing the specific industrial requirements, with both design and development of embedded security, privacy and dependability (SPD) possible via standardised design methods.

Figure 1: Measurable security, privacy and dependability (SPD) applied in various domains

The size of the project allowed expertise to be brought together, which had not previously been possible, and for prototypes in totally different application areas, even extended with unplanned application areas. Through SHIELD we have *(i)* achieved a de-facto standard for measurable security, privacy and dependability, *(ii)* developed, implemented and tested roughly 40 security-enhancing prototypes in response to specific industrial requests, and *(iii)* applied the methodology in four different domains, proving how generic the approach is.

Having piloted measurable and composable security in pSHIELD, the methodology was successfully applied by SHIELD in four business areas and has thereby contributed to solving the specific societal challenge of measurable Security, Privacy and Dependability. With methodologies for measurable security far from being standard, new ground had to be explored and this led to the development of around 40 prototypes that enhance security, ranging from 'secure boot', 'trusted execution environments' and 'adaptable radio interfaces' to 'different implementations of middleware for measuring security'. The methodology for composable security provides the configuration needed to fulfil a security requirement.

Business Impact

The Biometric Face Recognition System by Eurotech is a good example of business impact in this privacy-compliant, IP-based recognition system that detects human faces and processes them automatically, monitoring the transit of people through checkpoints and access passages in restricted areas. Another is the Norwegian Centre of Excellence on Smart Grids, where measurable SPD was applied to monitor and control energy consumption due to the increasing use of car recharging at the same time as house heating (in weekend houses), which overloads the grid. The energy consumption profile shows what equipment people own and the SHIELD methodology keeps this information private and secure and thereby promotes the business model of the privacy-aware smart-grid provider. Another example addressed the need of the transport domain. Composable security with SHIELD can enable trains to continue operating, albeit at a reduced speed, if one signal is not working but the track (in a station) can still be observed.

The demonstration of a novel software concept for unmanned aerial vehicles (UAV/UAS or Drones) has proved to be a real breakthrough not specifically targeted when SHIELD began. Alfatroll's IQ_Engine, a search-engine based steering system for UAVs, was successfully prototyped together with the OMNIA communication unit of Selex ES. This has prompted specific requests from industry to use UAV for unmanned monitoring at sea (oil and fish) and for the power-line infrastructure in Norway. The project also demonstrated that embedded systems can be configured in compliance with the security, privacy and security goal of the operator of the system as well as enabled the introduction of measurable and composable security in a variety of market segments, with a large number of technology prototypes supporting the specific SPD requirements of industrial applications in the respective domain. These prototypes will help our partners to stay competitive and gain market share, something that Eurotech and Seek and Find have already experienced with their products. In terms of new products in existing markets, SHIELD has provided measurable security as a dimension to the world of embedded devices, thereby focusing more on enhancing products rather than creating new ones. However, the UAS collaboration has pushed the products closer to the market, and attracted customers looking for autonomous solutions.

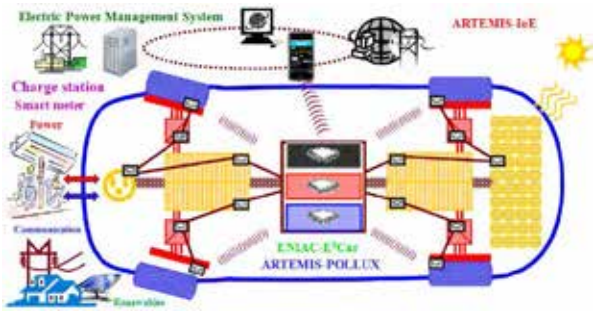
The impact of security will only grow and in the shift from Internet to the Internet of Things and cyber-attacks on sensor networks, prevention is a key issue. ABI Research addressed the presence of mainstream M2M solutions within critical information infrastructure such as utilities, healthcare and finance, and estimated a market volume of USD 752 million in 2017. The market need for measurable SPD could run up to more than 5 billion euros.

1.4 POLLUX & IoE

POLLUX (March. 2010-Feb. 2013)
IoE (May 2011- April 2014)
Interview with Ovidiu Vermesan, SINTEF

Challenge

The societal challenge addressed by the POLLUX project centred on electro-mobility, especially with respect to tackling efficient energy management and making the switch from architectures based on the combustion engine to new architectures dedicated to electric mobility with a natural fit to X-by-wire concepts for semi-automatic parking assistance for urban electric vehicles. The IoE project focused on the ecosystem for energy generation, supply, distribution and consumption, and more specifically the micro-grid ecosystem, targeting the transport and control of small amounts of energy in a similar way to data transfer within/across the internet. In this domain one of the main challenges is the bi-directional transport of energy.



Achievement

POLLUX addressed partly automated driving and parking, and demonstrated that the close-to-real feedback from the vehicle dynamics and from the road surface can be generated and transmitted to the steering wheel and braking or accelerating pedal (force feedback). The focus on the steer-by-wire system highlighted the benefits of system and functional integration as well as the need for functional safety requirements. Several demonstrators were developed for single and multi-motor compute architectures with specific microcontrollers for each demo. The beauty of this project was that hardware, software and OEM companies (FIAT and Peugeot) were involved, which enabled complete solutions to be realised.

The Project developed the EV architecture and the technology that form the basis for future development of autonomous driving/parking, communication network in the vehicle that

Duracar
HMI X-by-Wire, Force Feedback Pedal

Think
X-by-Wire, Parking Assistance

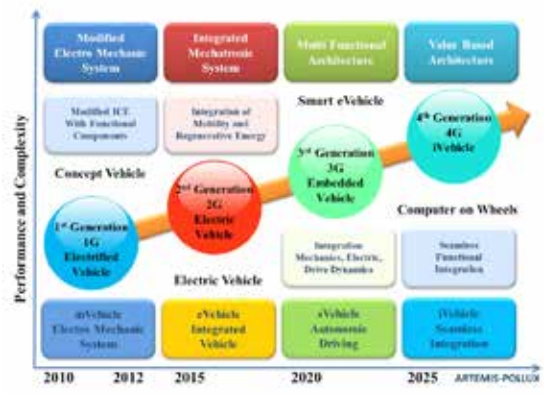
Fiat 500 HEV
Multicore processing motor controller, FlexRay Networking, Battery Management System

City Motion
Vehicle Controller, HMI, DC-DC Converter, Battery Management System, Partial CAN Networking

Test Bench Vehicle - PSA Peugeot Citroën
Battery Management, Multi propulsion power train, Multicore processing, PLC networking, FlexRay networking, V2I, V2G integration

allows for the future Ethernet backbone architecture and advanced human machine interfaces for performing the necessary communication services, inside and outside the vehicle (Vehicle to Vehicle – 'V2V', Vehicle to Infrastructure – 'V2I', Vehicle to Grid (V2G) and Internet Connection (V2G+I)).

One of the main achievements of the ARTEMIS POLLUX project was to propose a roadmap for electric vehicle generations as illustrated below.



Electric vehicle generations

The **Internet of Energy** project addressed electric mobility with specific reference to the Smart Grid, which is expected to implement a new concept of energy transmission and a distribution network that is able to efficiently route the energy produced from both concentrated and distributed plants right through to the final user, or prosumer (being both producer and consumer) with a high level of security and quality of supply. In other words, a kind of 'internet' in which energy is managed similarly to data, across routers and gateways that can autonomously decide the best pathway to the destination with the best integrity levels.

In this respect the 'Internet of Energy' concept is defined as a network infrastructure based on standard and interoperable communication transceivers, gateways and protocols that allow a real time balance between local plus global generation and storage capability together with the energy demand, creating a high level of consumer awareness and involvement. The targeted applications are illustrated below.

This micro grid ecosystem addresses in fact a whole new market, whose parameters are sustainability and micro grid autonomy; in fact, the micro grid is not continuously connected to the main power grid. Energy brokers, which could be a residential building, for example, are developed to optimise power supply and demand on the micro grid.

Business Impact - Highlights

Dual core microcontrollers developed in the POLLUX project target complex and safety-critical systems in the automotive sector. These microcontrollers are used in the development of safety-critical applications since they were specifically designed to meet and have been deemed suitable for use in safety integrity level 3 (SIL3). POLLUX addressed the requirements and specifications of dual-core microcontrollers that include the standard definitions of automotive safety standard ISO26262, flanking the industrial safety standard IEC61508.

The project also developed CAN (Control Area Network) Partial Networking, a major innovation in power efficiency. The standalone CAN transceiver and system basis chip is the world's first highly integrated solution that supports CAN Partial Networking, thereby giving design engineers precision control over a vehicle's bus communication network.

The project generated the EV (Electric Vehicle) architecture

and the technology that form the basis for the future development of autonomous driving/parking, as well as creating a communication network in the vehicle that allows for the future Ethernet backbone architecture and advanced human-machine interfaces to perform the necessary communication services, inside and outside the vehicle.

The technology and concepts developed by the project are used today in the development of the 3G generation of smart e-Vehicles that will be on the market in the next few years. The technology allows the penetration of electric vehicles from e-bikes and lightweight electric vehicles to electric buses.

The technology developed by the project can be scaled to different classes of electric vehicles. Lightweight EVs is one of the largest and fastest growing electric vehicle markets where light electric vehicles (e-bikes, nano, micro class electric vehicles) will proliferate in cities due to the demand for clean transportation.

Internet of Energy for Electric Mobility developed the technology that supports the ecosystem for energy generation, supply, distribution and consumption, and more specifically the micro-grid ecosystem.

The concepts and technology developed allow the transport and control of small amounts of energy, in a way that is similar to data transfer within/across the internet by solving one of the main challenges in this domain; the bi-directional transport of energy. The prosumer is the end-user of such systems.

IoE contributes to reference design and architectures by addressing architectural and functional dependability, thus ensuring secure, reliable and timely system services and the design, development and deployment of ubiquitous electronics and software systems.

Many future products and services are expected to be rolled out of the IoE project achievements, such as the development of five bi-directional, on-board chargers based on different topologies and the development and deployment of four building energy management gateways demonstrating different functionalities. The key features of integration and interoperability were demonstrated in two software platforms for the federation of information around charger stations that realised 50KW DC and 22kW 3 phase AC fast charging with PLC, GPRS and NFC communication features. In addition, two energy storage solutions (Li-Ion, Fly-Wheel) were demonstrated and a communication protocol for energy storage units proposed. Other achievements include an urban traffic simulation tool developed that can be combined with grid information and a vehicle controller touch screen display and multiple communication protocols (Wi-Fi, 3G, NFC, CAN).

The Internet of Energy concept facilitates the development of future Smart Grid deployment and the integration of Energy Bi-directional Switch, Energy Hub Energy Cloud and Energy Storage Cloud concepts. The Energy Hub combined charging stations, improved operating efficiencies and cost savings, accelerated fault finding and improved power quality as well as facilitated the integration of renewable and distributed generation sources in the city context using micro/nano grid deployments and cloud energy source distribution.

New requirements for power matching have been defined for operating micro/nano grid systems that incorporate the necessary flexibility to accommodate inherently intermittent renewable technologies, such as wind and solar.

Energy Storage Cloud allows the seamless integration of local and mobile energy storage (distributed energy banks to a standalone or part of the buildings/homes/parking/poles infrastructure, second-life battery packs, dynamically generated battery banks-fleet of vehicles connected when charging or when parking) into the Energy Cloud using the communication interface and moving towards energy as a service implementation.

The results of the project have been used to accelerate electric vehicle uptake in the Member States involved and focus on interoperability, sustainable infrastructure set-up and network planning alongside infrastructure deployment.

An example of exploitation is the case of ABB B.V. (Netherlands), manufacturer of fast charge solutions and partner of the IoE consortium that is leading the ELECTRIC project funded by the 'Trans-European Transport Networks (TEN-T). Via TEN-T the European Union contributes to the internal market aim to harmonise and better connect transport systems in Europe. The objective of the TEN-T programme is to co-fund investments in transport infrastructure in order to enhance European transport networks. The total budget of this project amounts to about 8.4 million euros. Ultimately the project targets the creation of an open access, fast charging corridor situated along major motorways connecting Sweden, Denmark, Germany and the Netherlands via a total of 155 foreseen chargers, with up to 30 in the Netherlands, 23 in Denmark, 35 in Sweden and 67 in Germany.

1.5 CHIRON

Silvio Bonfiglio | BarcoCompany
Project: CHIRON (2010 – 2013)

Challenge

The ARTEMIS project CHIRON (Cyclic and person-centric Health management: Integrated appRoach for hOme, mobile and clinical eNvironments) addressed the complete care cycle and design issues relating to patient monitoring and the timely detection of degenerative trends, diagnosis and assessment (through signal and image processing), and treatment and intervention (image-based procedures in cardiovascular intervention). The aim was to develop a sophisticated solution through a reference architecture for all-round, person-centric health management.

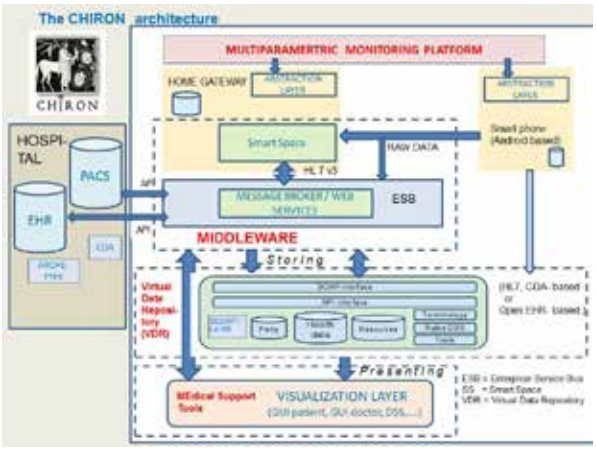
Achievements

The project addressed and correlated the needs of all three beneficiaries of the healthcare process – the patients that use the services, the medical professionals and the whole community. The emphasis was on putting the patient at the core of the whole healthcare cycle by considering these patients as 'persons' with their own individual attributes and identities, with the aim of empowering them to manage their own health. CHIRON accomplished a shift, moving from treatment to prevention, by fostering the seamless integration of clinical, home environment and mobile settings in a concept of a 'continuum of care'.

By developing a reference architecture for personal healthcare, CHIRON ensures the interoperability between heterogeneous devices and services so that these are seamlessly integrated with the clinical workflow. This can only be achieved through reliable and secure patient data management according to the HL7 standard, which provides standards for interoperability that improve care delivery, optimise workflow, reduce ambiguity and enhance knowledge transfer among all of the stakeholders. The requirements identified by CHIRON, regarding interoperability and data security together with the reference architecture, provide the stipulations for the solutions offered by another ARTEMIS project, SHIELD.

CHIRON has contributed greatly to helping to shift healthcare processes from the hospitals and doctor's surgery to non-clinical settings like people's homes and other locations. Results in the area of image processing are essential to facilitating this shift and include the analysis of cardiac tissues from 3D ultrasound images, the integration of X-ray and ultrasound images, high-dynamic-range (HDR) display and image processing, iPad calibration by optimised visual calibration algorithms and the integration of a patient's data with medical images.

CHIRON has combined state-of-the art technologies and innovative solutions into an integrated framework that has been designed for effective and person-centric health management in which the patient, the medical professionals (both inside and outside the hospital environment) and the whole community represent the stakeholders of the entire healthcare process.



Business impact

The outcome of the CHIRON project has translated very tangibly into the business arena, for instance in the Philips EchoNavigator that provides intelligently integrated X-ray and 3D ultrasound images into one intuitive and interactive view as well as easy-to-use system navigation and better communication between the multidisciplinary team carrying out the procedure. The EchoNavigator is helping interventional cardiologists and cardiac surgeons to perform minimally-invasive structural heart disease repairs.

In the Barco QAWeb Mobile, Barco has released a new version of its QA and calibration App for medical image viewing on the iPad. An optimised visual calibration algorithm, one of the outcomes of the research work done in the CHIRON project, was used to calibrate and perform quality assurance tests on iPad devices. Once properly calibrated, the mobile tablet can display medical images with excellent clarity. A calibrated tablet is ideal for reviewing clinical images during doctor's rounds and represents a convenient alternative when emergency situations arise and a diagnostic display is not available.

The Mobilis framework, a completely functional standalone framework solution connected to the client servers, is a development bio-sensoric tool derived from the results of the CHIRON project. It helps developers, engineering companies and research institutes to create a flexible solution for a variety of uses, such as eHealth, telehealth, telecare, wellness, first responders and other uses. The data can be synchronised via secure connections.

There were also two unexpected spin-offs. W LAB found the work on wireless sensor development in the project to be useful also in the construction sector. In an application for the construction of the new line of the Rome underground, the wireless sensor network is used for remote and continuous monitoring of the strength of the structure, replacing time-consuming regular manual measurements. The mobile platform has also attracted attention from the fitness market.

1.7 High Profile

Frank van der Linden | Philips Medical Systems NL B.V., Netherlands
Project: High Profile (1 April 2011 to 30 June 2014)
Date interview: 5 August 2014

Challenge

Healthcare is one of the main societal challenges of today and the future. One very specific challenge concerns the diagnosis of brain diseases such as tumours, strokes and epileptic fits. This requires medical staff to have a better picture, and thereby insight, of the brain as well as more detailed information about the location of brain phenomena and diseases. Until recently brain images have been susceptible to considerable distortion for a variety of reasons, such as the relatively weak (brain) signals being swamped in an electrically noisy environment and fatty tissue that prevents a clear scan.

Achievement

The goal of the High Profile project was to improve the quality of brain images from acquisition and processing to the visualisation of the results. Not only will this improve the workflow of the hospital but will also produce higher quality images that are more quickly available.

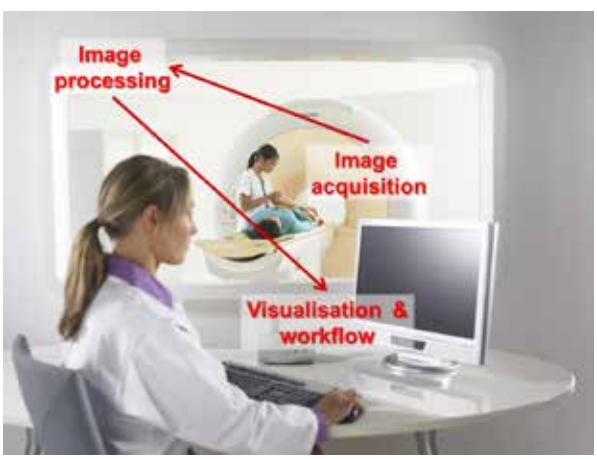
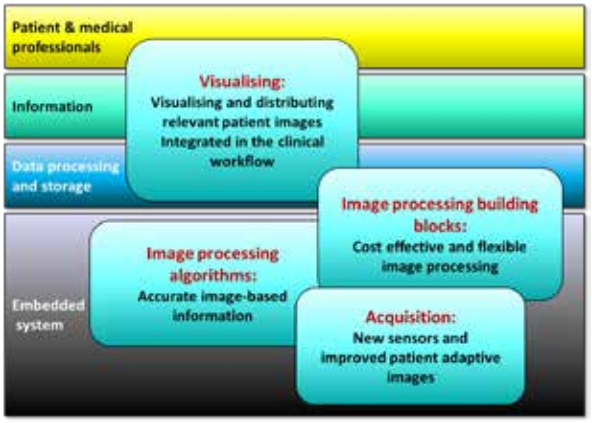


Figure 1: End-to-end neuro-imaging

A set of tangible targets was established covering the whole chain from acquisition to workflow in the hospital. At the image acquisition stage, the removal of noise, distortions and artefacts originating from the context acquisition and the reduction of the size and number of disturbances in images helped to improve the raw images and signals. Also the better mapping between images and signals, and low level of

distortion, enabled the precise location of signal sources in the brain to be shown.

In terms of interpreting signal patterns, this is now much better supported so that fewer interpretation errors are made and the diagnosis can be made more quickly. For instance, improvements in High Profile mean that the patterns of brainwaves of epileptic patients can be recognised and better localised. The use of standard data processing equipment instead of specialised signal-processing hardware produces a consistent result that can be used by the doctor. For instance, this is applied for EEG that delivers 80 separate electric signals. This has been facilitated by information extraction algorithms and acceleration through multicore computing that transform the processed raw images into clearly presented medical information. Of course, with regard to the protection of private data, this guarantee of confidentiality of medical image information is incorporated into the medical workflow.



Field of activity

A total of six image acquisition sources, data fusion, data security and three visualisation environments were part of the project.

Business Impact

Although a clinical evaluation has yet to take place, the project results for MRI (magnetic resonance imaging) and EEG image improvement have already been taken on board by the UMC (University Medical Centre) Utrecht, one of the partners in the project while Philips is already using the project results to upgrade its MRI equipment. Philips has also added the improvements made by High Profile to its equipment software to suppress noise by deleting the noise created by the fatty tissue and/or water in the brain, which enables the zoom capability to look even deeper into specific areas of the brain.

One unanticipated result was the discovery of a new method for creating brain images by infrared technology that, in the future, might become an alternative to EEG technology to measure oxygen saturation in the cortex.

In addition to this, a spill-over from the CHIRON project was incorporated in the project: the presentation of brain images on iPads/tablets in the medical workflow under strict security and privacy conditions. Two Dutch companies are actively developing products based on this technology: AnyWi and Medvision360 (formerly called ZorgGemak). This is considered a newly created market segment. PS-Medtech (NL) has also created a new business line for a novel product whereby the projection of 3D brain images can be used on iPads. Finally, results achieved in High Profile will be incorporated into a new project: ALMARVI.

1.8 DEMANES

DEMANES 2012-05-01 - 2015-04-30

DEMANES, DEsign, Monitoring and Operation of Adaptive Networked Embedded Systems
Business Impact Interview: Matthijs Leeuw and Yolanda Rieter,

Challenge

The main challenge taken up by DEMANES was to provide component-based methods, framework and tools for the development of runtime adaptive systems, making them capable of reacting to changes in themselves, in their environment and in users' needs. This meant creating a toolkit that supports the design of adaptive multi-sensor networks for application domains including Cooperating Sensors at Home, Smart Safe &Secure Urban Transport and Environment, and Smart Airport Management.

Achievements

In all these domains, the project improved several functions that these adaptive networks are able to use to reduce operational costs; since the systems based on these networks are more flexible, less operational effort is needed to prepare and configure such systems for their tasks. Where such configuration had been manual in the past, the application of adaptive networks allows such configurations to be automated. An example of this is the Smart Home Lighting System developed in Spain. The DevLab members used their expertise in wireless sensor network technology and applications to help model and design the Adaptive Networked Embedded System and, along with Inabensa, has taken a leading role in the Smart Home use case.

The large size of the consortium and project was central to achieving the results, since many disciplines needed to be brought together to tackle the objectives of DEMANES. DEMANES results will be used by the follow-up project ACCUS (2013-06-01/ 2016-05-31), in which the connections of smart systems is the objective. Where formerly smart systems were standalone, by connecting these systems, information can be shared to improve efficiency and effectiveness, as in the coupling of the Smart Home to the Smart Grid that is a focus of ACCUS.

Business impact

The project's Smart Environment for Assisted Living demonstrator is expected to generate new business and services, including plans for a Finnish start-up company,

SenSoftia (www.sensoftia.com), to create new business opportunities, possibly in cooperation with Mega Electronics (www.megaemg.com), based on the mobile health results of the DEMANES project. Established by employees of UEF's Computational Intelligence (CI) research group in January 2014, SenSoftia is very active in product development for several hardware/software products related to telehealth, healthcare sensor integration, location-aware, air quality measurement, schedule/event, machine vision, data analysis, data security, wireless communication and applications/ services for learning systems as well as hospital information systems, cyber-physical systems and mobile platforms. SenSoftia has also had a four-year H2020 project accepted, to start in March 2015.

An unexpected application encountered during the project was the Smart Container Terminal for the port of Rotterdam. Transport plans are constantly being revised and updated on the basis of incomplete and unreliable data, leading to transport that often differs from the initial plan. By using floating truck data (pooling data from trucks heading towards a container terminal for pick-up or delivery), more efficient workflow is achieved since the terminal is more aware of likely subsequent actions. Several new services may be based on this pilot, such as system management services by Prime Data BV (a TNO spin-off company) and sophisticated climate

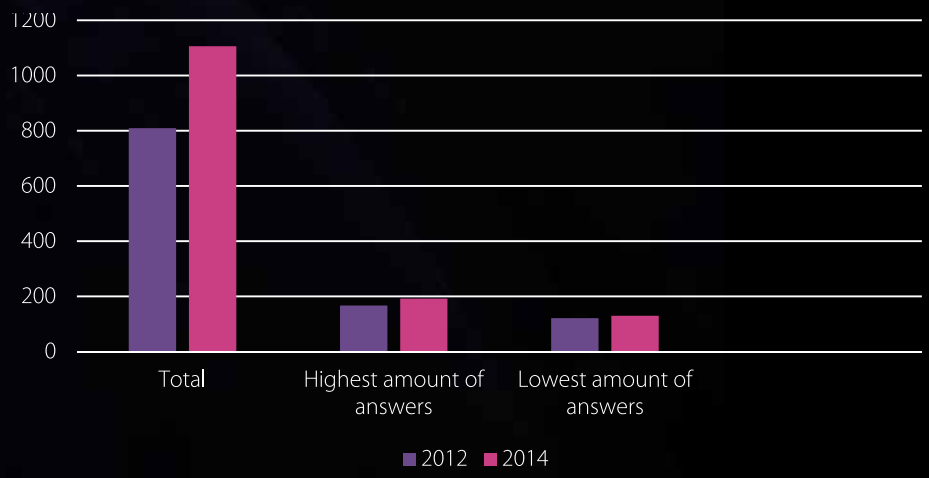
monitoring and control systems within Dutch greenhouses.

Another business impact highlight is the use made by Mega Electronics of two device platforms developed for the Smart Environment for Assisted Living demonstrator: eMotion Faros and eMotion Biolink. eMotion Faros is a small bio-signal measurement device for electrocardiography (ECG), electromyography (EMG), heart rate variability (HRV) and physical activity measurements in cardiology, telemedicine, occupational medicine as well as cardiovascular and neuromuscular research. Within the scope of cardiology, long-term arrhythmia monitoring is an important use case and since the device has internal memory and wireless transmitting capabilities, it can be used as an autonomous recorder and a remote-sensing component of a telemedicine system. eMotion Biolink is a connecting unit designed to connect eMotion Faros devices together and to external systems. The eMotion Biolink unit can be integrated into the building and act as a real-time data link between a patient recovering from a cardiac surgery and a supervising physician. When using eMotion Faros devices in cardiac rehabilitation, the patients in a room can be measured simultaneously and the data can be shown on a single screen or forwarded to remote analysis through eMotion Biolink.

Survey results on Metrics & Success Criteria of ARTEMIS

The questionnaire was sent to slightly more than 1100 participants in different calls of the ARTEMIS programme: the amount of answers to different questions varied between 12% and 17% of the participants, with an average 13-14% answering the questions. There is a balanced response from large companies, SMEs and research institutes. In total 62% of the answers came from industry. Compared to 2012, there was a slightly higher amount of respondents from universities and research institutes (from 32% to 38%), while the amount of answers from SMEs has declined (from 33% to 28%). The amount of answers from large enterprises remained almost equal (from 35% to 34%).

Figure 1
Number of Respondents



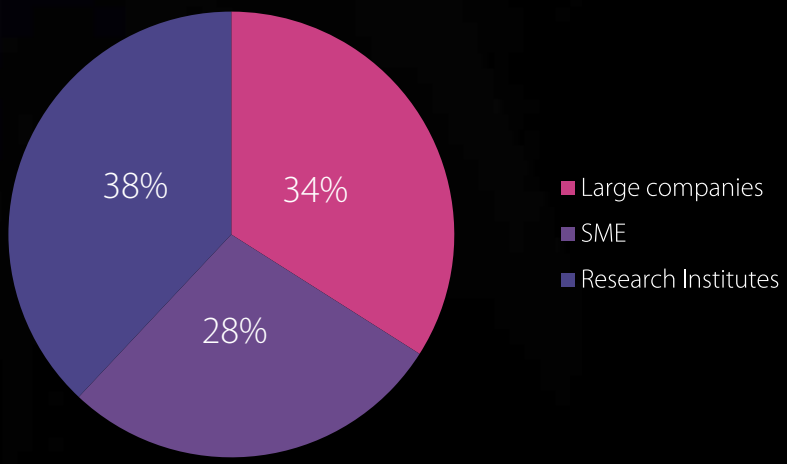
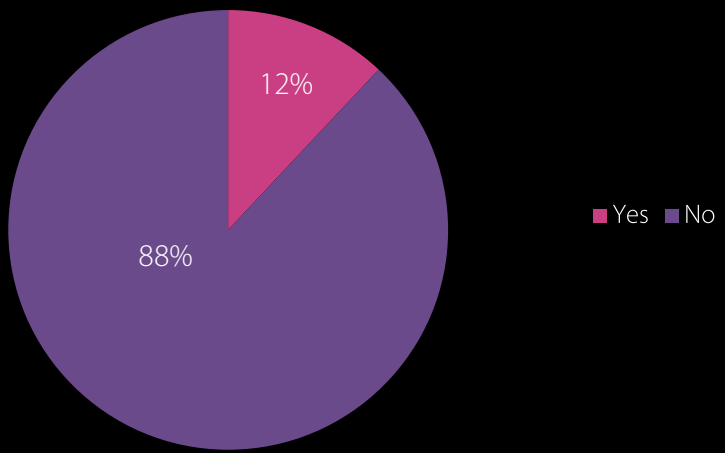


Figure 2
Are you Project Leader ?



Results on sub-theme 1: Focusing on common R&D agendas more effectively

The first sub-theme focuses on the way consortia are set up and how this influences the R&D agendas of the participating partners. It also looks at the adequacy of specific ARTEMIS instruments (e.g. Centres of Innovation Excellence) and the positioning of the ARTEMIS programme compared to other programmes at national and EU level. Finally, it looks to the strengths and the weaknesses of how the ARTEMIS programme is currently organised and run.

3.1 Consortia & Partnerships

The consortia were mainly formed from pre-existing partnerships. 76 % of the partners that replied already had partnerships before the project was set up. This is approximately the same figure as in 2010 and in 2012 where respectively 73 % and 75% of the partners already had partnerships.
The second point of contact is Brokerage events (>30%). National Contact Points and the Partner Search Tool are much lower (less than 15 %).

Figures in 2012 and 2014 are very similar – there are only very minor deviations. Contacts via brokerage events seem to have declined while national contact points had a somewhat bigger stake in 2014 compared to 2012.

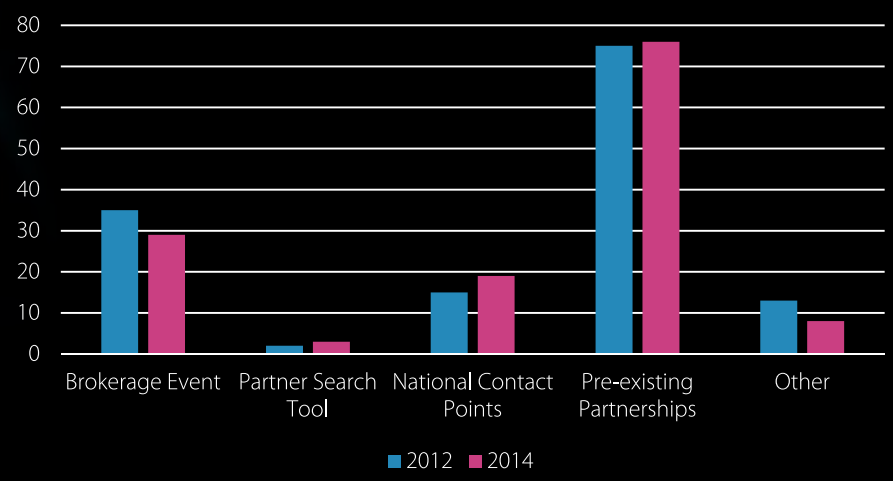


Figure 3
Forming the Consortium

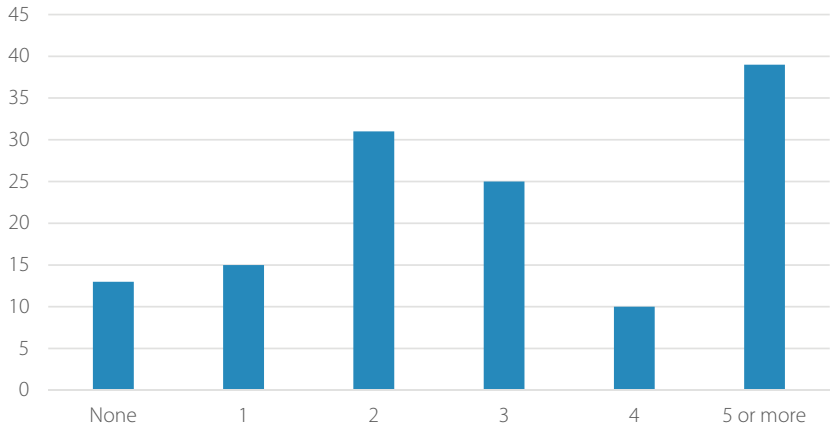
Concerning the way the consortia were formed, some more concrete answers were given:

- Personal contacts (several answers)
- Approached by a large company or a research institute
- Existing networks
- Merger of 2 projects
- Previous project consortium

In the latest questionnaire, each respondent formed an average of at least 3.2 new partnerships through participation in a project consortium. This figure is a minimum, as we have taken an amount of '5' in the calculation for the column '5 or more'. This is slightly lower than in 2012, where the average of partnerships was 4.3. However, if we had taken the figure '8' instead of '5' in the column of '5 or more', then we would have had the same number in 2014 as in 2012.

The spread over the amount of partnerships is shown below.

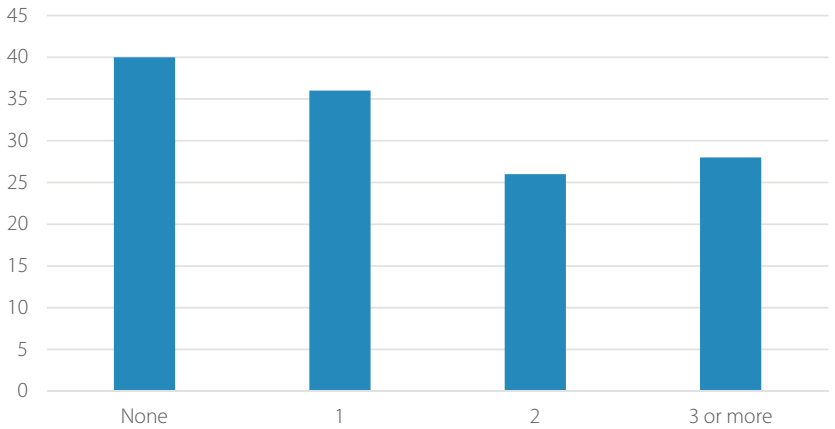
Figure 4 New Partnerships



In these new partnerships 70% involve an SME, compared to 50% in 2012 and 33% in 2010. So we see a continued growth of SME involvement in the creation of new partnerships due to project participation.

The spread of partnerships involving an SME is shown below.

Figure 5 New Partnerships with SMEs



3.2 Future

83% want to continue the cooperation with an SME after the project, compared to 78% in 2012 and 40% in 2010. This shows the trend that cooperation with SMEs remain a key asset in the ARTEMIS programme.
28 respondents (17%) are currently thinking about creating a new company based on the project results, compared to 10 (8%) in 2012, investigating this in more detail. Almost all of them plan one spin-out company. Here we see a strong growth of the entrepreneurial spirit in the ARTEMIS programme.

3.3 COIE

23% of the respondents plan interaction with a Centre of Innovation Excellence (CoIE). This is a reduction of 8%, compared to 2012, where 31% planned to interact with a CoIE. This is probably due to the fact that the CoIE concept was quite new in 2012 and a few CoIEs started in 2012. So we were in a start-up phase and now have reached some level of maturity.

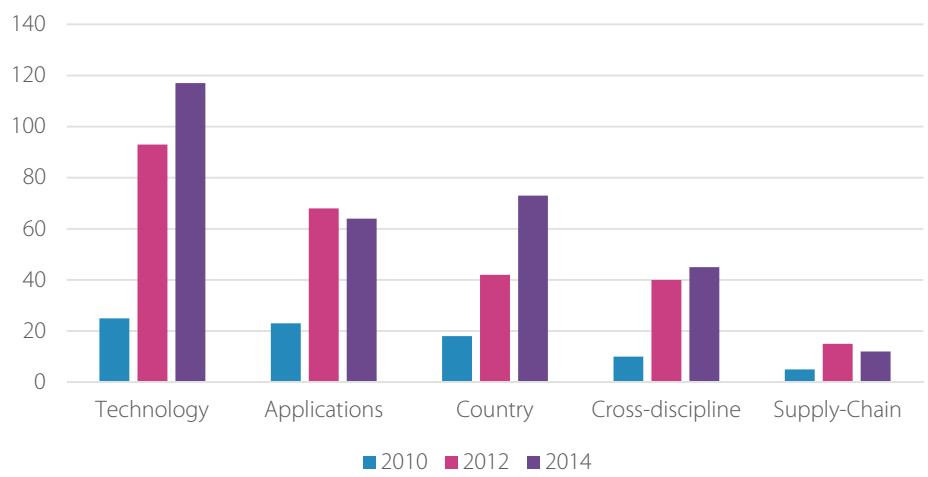
4% plan to create a new CoIE, compared to 9% in 2012.

Although the CoIE is still a valid working instrument within the ARTEMIS community, it probably needs some new promotion and marketing in order not to lose momentum.

3.4 Cooperation

The cooperation remains mainly along the technology axis. Compared to 2012, we see a strong growth of the cooperation along the technology and along the country axis. The country axis has become even bigger that the application axis, probably due to strong international collaboration at technology level, backed up by strong local country-wide organised sub-consortia in large projects that have significant day-to-day interaction. It is probably also due to the administrative and funding specificities of the ARTEMIS programme, which encourage the formation of strong country consortiums already at the proposal phase with own use cases and demonstrators.

Figure 6
Cooperation Axis



3.5 Impact on internal R&D agenda

In 2010 this was an open question and these topics emerged without clear figures. The multiple-choice questions in 2012 and 2014 made it was possible to create a ranking.

The top three consists mainly of increased R&D knowledge/experience, R&D partnerships and R&D scope. In the top 3, positions 2 and 3 have changed places. The R&D scope is becoming more important than the R&D partnership. The topic "Discussion about future projects' went forward considerably in 2014 and moved up three places from 7 in 2012 to 4 in 2014. The topics "Possibility to create new business opportunities' and "More effective/efficient solutions' have become slightly more attractive.

Some examples that were given on the impact are the 'coupling of tools 'and the 'new applications for the prototype tools under development'.

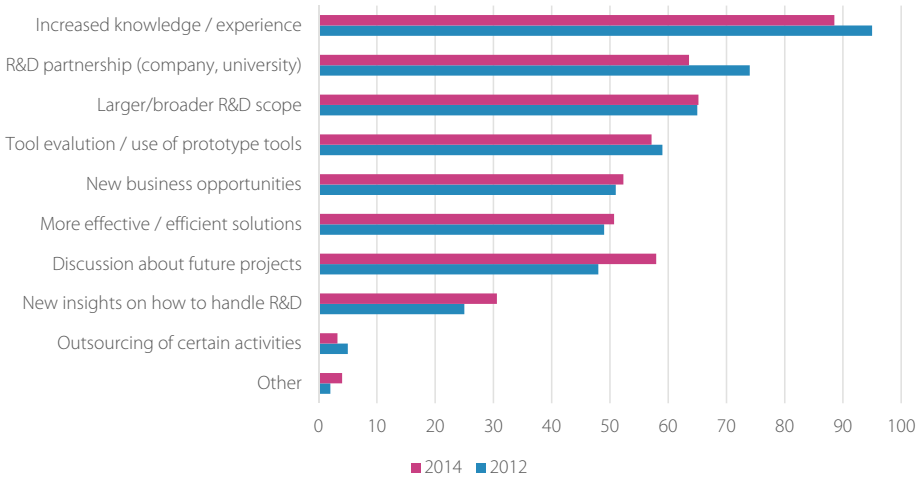


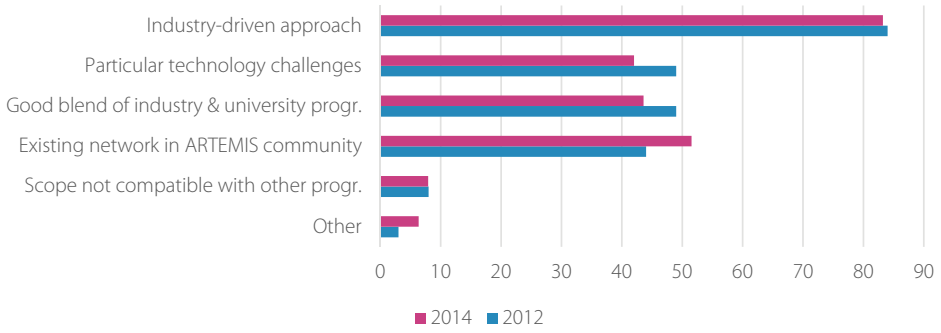
Figure 7
Impact on Internal R&D Agenda

3.6 Why ARTEMIS?

An 'industry-driven approach' in the ARTEMIS programme remains the top reason to join the ARTEMIS programme. The 'Existing Network in the ARTEMIS Community' was the main newcomer in the answers in 2012 – but here we had to take into account that this was not yet so prevalent in 2010 given the recent incorporation of ARTEMIS at that time and the network consisted mainly of the founders and some of their partners. In 2014, this item has climbed from number 4 to number 2. The items 'particular technology challenges' and 'existing network in the ARTEMIS community' have diminished slightly in importance.

Some specific examples are the following: major companies participating, recommended by the project leader, possibility to develop own ideas, lean and fast PO phase, good fit with SRA.

Figure 8
Why ARTEMIS ?

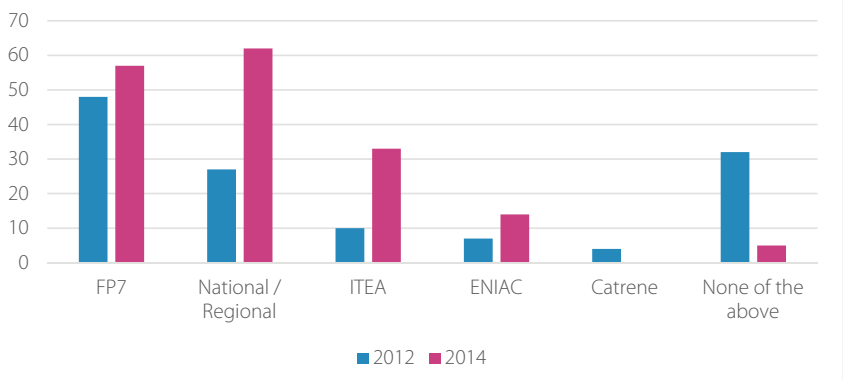


Concerning alternative funding schemes, national/regional funding has taken top position. These are the conclusions in more detail:

- National / Regional rose from 3 in 2010 to 2 in 2012 and to number 1 in 2014. It is a potential alternative solution for 62%.
- FP7 moved from the number 1 position to number 2, slightly behind number 1 (57% of the respondents).
- The top 3 is completed by 'ITEA', which has been marginal in the past and now has moved ahead considerably (33%).
- ENIAC is fourth with 14%.

However, we have to take into account that only 21 participants answered that question in 2014 (less than 15% of the respondents). Compared to 2012 we think that some people did not answer while in 2012 they explicitly mentioned 'none of the above' as an answer.

Figure 9
Alternative Programmes



3.7 Strengths and Weaknesses of ARTEMIS

In 2014, the item 'Industry-driven/industry relevance' was again top. In 2010 it was also top but in 2012 slipped back to 2nd.

The item "Partner alliances/consortium" was again 2nd as in 2010 (3rd in 2012).

The item 'Combination of scientific and industrial views' which jumped to head the list in 2012, moved back to 3rd, although the difference with 2nd is minimal (1% of the respondents).
We can state that the top 4 remains stable with the following items:

I Industry-driven, industry relevance (67% of respondents)
II Partner alliances / consortium (57% of respondents)
III Combination of scientific and industrial views (56% of the respondents)
IV Cross-domain approach (36% of respondents)

In addition to the above, it is worthwhile noting the drastic fall in the aspect 'both national & European support'.

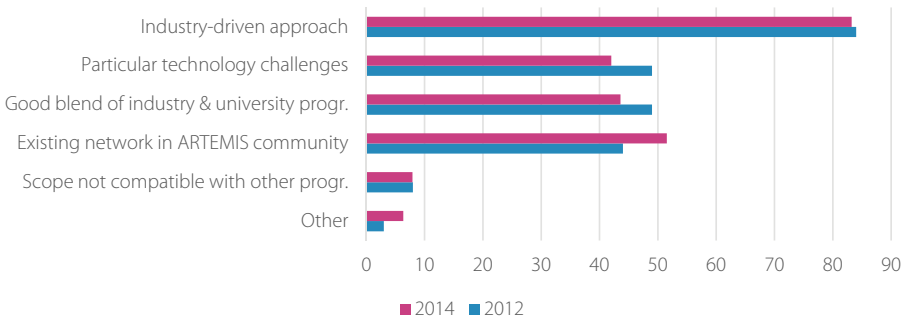


Figure 10
Strenghts

Concerning weaknesses, the same two items remain top:

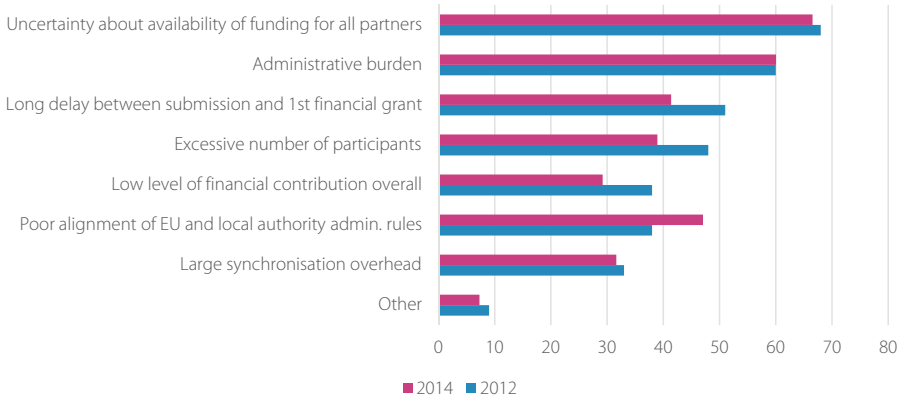
- Uncertainty about availability of funding for all partners
- Administrative burden

The item 'Poor alignment of EU and local authority administrative rules' has jumped from 6th to 3rd.
Some items have improved:

- Long delay between submission and 1st financial grant
- Excessive number of participants
- Low level of financial contribution overall

So the main concerns about the programme have to do with administrative complexity and EU versus local authority alignments.

Figure 11
Weaknesses



3.8 Conclusions theme 1

I Collaboration remains very successful and the same order of magnitude as in 2012. The creation of new partnerships is at first sight slightly lower, but this is due to the methodology of calculation. So, in practice, it also remains approximately at the same level as in 2012. However, the SME involvement in these new partnerships grew to 70% in 2014 (from 50% in 2012 and 33% in 2010). The partnerships are mainly based along the technology axis and this is even more explicit than in 2012. Cooperation at the country axis is 2nd at the cost of the application axis, which is now 3rd.

II The level of interaction with a CoIE has become less popular than in 2012 (from 31% to 23%). This is probably due to the fact that the CoIE concept was quite new in 2012 and a few CoIEs started in 2012. So we were in a start-up phase and have now reached some level of maturity. However, the creation of new CoIEs has also lost some momentum, so it is probably worthwhile setting up some new promotion and marketing around CoIEs.

III The main reason for working in ARTEMIS remains the industry-driven approach, for the 3rd time already. The possibility to work together within existing networks was new in 2012 and climbed from 4th in 2012 to 2nd in 2014. The impact on the R&D agenda remains 'having increased knowledge and experience thanks to participating in ARTEMIS projects'. Concerning alternative funding schemes, national/regional programs have climbed to 1st (FP7 and ITEA are 2nd and 3rd).

IV As a key strength, the topic 'industry-driven/industry-relevance' is again top, while the topic 'combination of scientific and industrial views' moved from 1st to 3rd, although the difference with 2nd ('partners alliances/consortium') is very slight. It is, however, hard to explain what the reason is as the number of respondents from universities increased in 2014 compared to 2012. Does it mean that university research has become more industrially driven? Key items for attention are 'uncertainty about availability of funding for all partners' and 'administrative' burden. They both remain at the same level, so no improvement was visible while in 3rd position came 'poor alignment of EU and local authorities' (6th in 2012). Some food for thought…

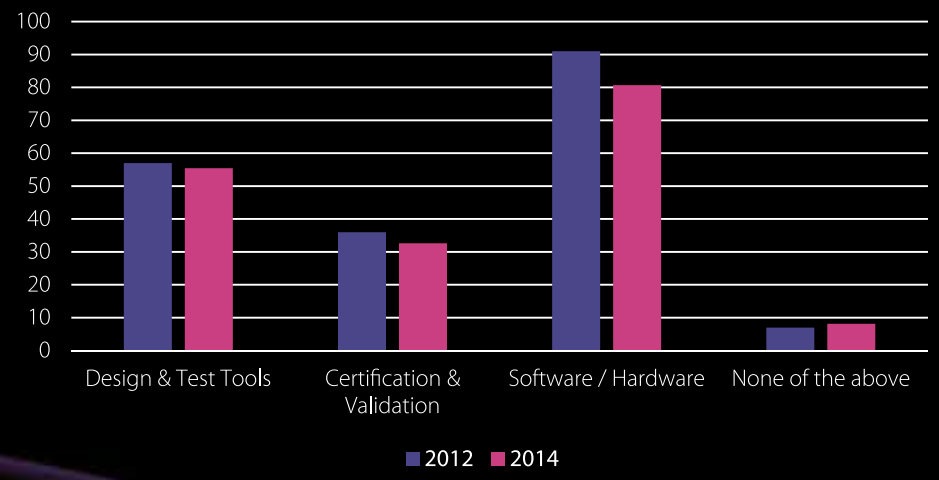
Results for sub-theme 2: Providing significant economic & societal benefits

The questions in the second sub-theme focus on the economic and societal benefits of the ARTEMIS programme. It looks at the markets currently addressed and envisioned by the participating partners in the programme as well as briefly into the business impact of all respondents. For some consortia a more in-depth qualitative questioning on Business Impact has been done and is documented in Chapter 1 of this publication. Finally the questions look into the application and societal domains in which ARTEMIS has an impact.

4.1 Market impact

The markets addressed can be split into 'Technology Markets' and 'Application Markets'.
In terms of 'Technology' the main market addressed is the hardware/software development (63% of the respondents), which has decreased slightly compared to 2012.
There is no major difference between 2012 and 2014.

Figure 12
ES Technologies



In terms of 'Applications', the automotive domain is the most represented (43% of the respondents). In other application domains there is an equal spread. The areas 'Building/Infrastructures' and 'Consumer Products' are slightly lower than all other application markets. 'Railways' and 'Aeroplanes/ Aerospace' has grown considerably, while 'Smart Spaces' has diminished quite a bit.

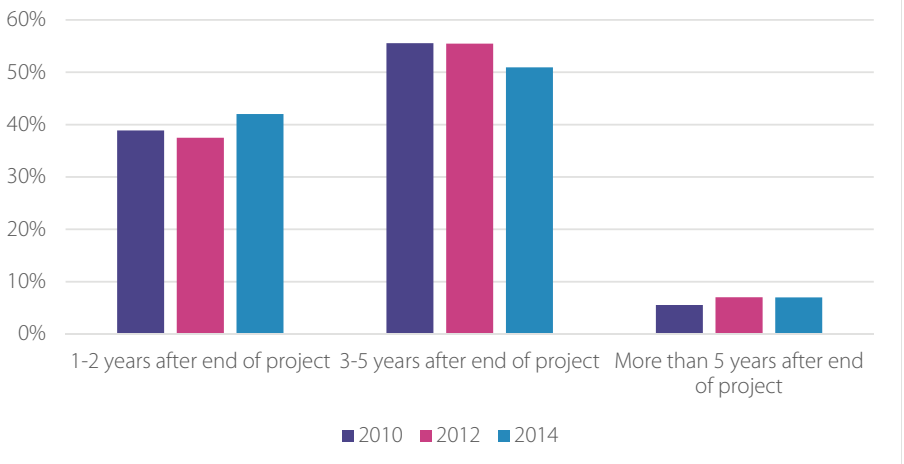
ARTEMIS Industry Association

' For a leading position of Europe in Embedded & Cyber-Physical Systems'

Figure 13
Applications

In terms of timeframe when project results will become available, the majority is 3-5 years after the end of the project, although it has decreased slightly. The timeframe of 1-2 years has grown slightly, which demonstrates the trend that R&D projects in ARTEMIS evolve more and more towards faster-time-to-market projects or to projects which are closer to market introduction than before.

Figure 14
Timeframe



4.2 Business impact

In terms of business impact, the top 3 answers in 2014 are:

- Reduced development costs (53% of respondents)
- Reduced time-to-market (41% of respondents)
- New Products (38% of the respondents)

.

Compared to 2012, 'Higher re-usability of components' was 3rd but has fallen to 4th. In 2014, the positions 4-7 are very close to each other, while the differences in 2012 were much more marked.

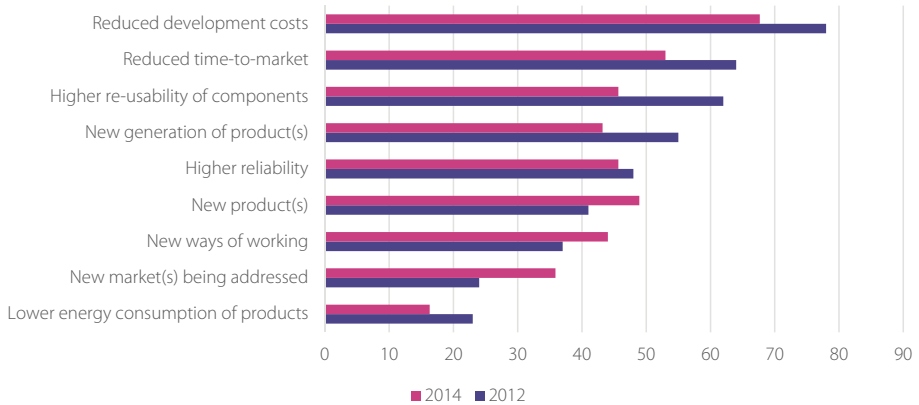


Figure 15 Business Impact

Some of the results mentioned in the questionnaire, were the following:

- EMMON technology is used with LivingPlanIT Smart City development in London City Airport.
- The EMMON architecture results are exploited together with Intel for a Smart City development in Dublin.
- The EMMON network architecture is being exploited together with Portugal Telecom to improve the energy efficiency of one of the largest Data Centres in Europe.
- Additional sales volume expected of 2000+ units in new markets within 2 years after project end.
- Expected development time to be reduced by 20-30% through cost effective use of multicore technology and related engineering tools with automatic code generation.
- Enable customer companies to adopt the solutions more quickly, such that faster growth of usage can be reached.
- More direct input from Human System Interaction into the architectural definition stage.
- Extension of products with new functions, enlarging our markets.
- More precise visualisation of the brain, leading to improved diagnosis and preparation for intervention for users of the system.
- Rough estimate that impact of project will lead to employment of approximately 20,000-30,000 direct jobs and 30,000 indirect jobs, created around 2020, plus an additional 20,000-30,000 manufacturing jobs that will be retained.
- The making of the products will be realised in half of the time, which means that R&D capabilities are doubled.

- New customers & new research projects under definition.
- More attractive products for some of our most demanding customers, resulting in increased interest from these customers to further cooperate with us.
- Better interoperability of our tools with other tools.
- Better fit of our products to the needs of the end-users.
- Better integration of end users' needs at the earliest stages of the design process for future systems (e.g. driving assistants), due to the advantage of the Virtual Human Centred Design platform under development.
- Lower risk to discover issues late during the design process.
- Reduction of aircraft weight by removing wires and using wireless sensor networks. Example: the Ariane 5 telemetry system contains of 600 to 800 sensors. Telemetry system control unit is centralised. Thousands of cables are spread all over the 40-metre launcher – cables make up 70 % of Ariane 5 avionics mass.
- Double turnover by addressing a new business segment in the area of safety analysis for automotive software.
- New infotainment devices for automotive and aeronautics.
- Better management tools for manufacturing plants and emergency dispatching.
- New quality control system developed, which will enable us to control the products in the different phases of production process, which will result in fewer complaints and lower production costs.
- New robotic tool available for Oil and Gas business.
- 5-10% increase of revenues by several projects.
- Reduction of risks by around 50% during installing and deployment of wireless sensor networks, in the areas of maintenance, reliability and dependability of the installation.
- The energy brokerage module of the Encourage middleware is expected to be exploited by the project partners working on development of energy management systems. This will give them a unique leading position within this highly competitive market.
- Increase our customer work in the areas of facility automation and conditions monitoring by 50,000 euros per year for at least 6 years.
- Triple the turnover in the Industrial Automation within a 5-year period.
- Developing a smart lighting system in one pilot city will leverage to at least 12 other cities.
- More collaborative engineering between companies organized around 'aspects' instead of around 'system components' (latter is characteristic for Tier-X co-ops). Also streamlining of everyday tool-chain administration across industry.
- Standardisation of communication protocols will substantially simplify new products and market penetration.
- Shorter reconfiguration of product lines (2-3 times faster).
- Our organisation, being the main developer of the new design flow and its automation tools, is preparing to establish a spin-off company that will exploit the flow and tools to deliver competitive design services. Through enabling creation of high-quality products several times faster and cheaper, our new design technology has big potential to bring sizable profits both to the embedded processor industry and to the numerous embedded and cyber-physical system companies as users of embedded processors. Moreover, it makes the application of embedded processors economically justified to more applications and shorter production series.

In terms of Business Impact, a number of project consortia have been interview and the more detailed outcome of these interviews and results can be found in Chapter 5.

4.3 Contribution to ARTEMIS AWP targets

One can see that the figures of 2014 do not differ too much from 2014. All are in the same order of magnitude, although one can see that the 3rd criterion 'Manage complexity increase by 25% with 10% reduction in effort' has decreased more strongly than the others.

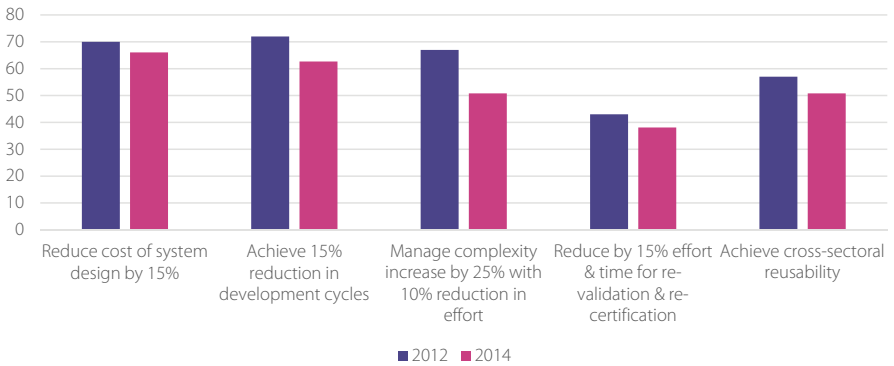


Figure 16 ARTEMIS Targets

Some more detailed clarification is given in Annex 2 (answers to an open question requesting more details on contribution to ARTEMIS AWP Targets).

4.4 Impact on R&D team size

Cooperation in ARTEMIS projects can have an impact on the team size, either positive or negative on the internal team size, and on extending the external team with external team members.
The figures from 2012 and 2014 deviate significantly.

The two highest figures can be found in the area of 'Increase of the internal team' and on 'No Impact on team-size'. In 2014, there is almost no impact in the area of 'Decreasing the internal team'. Increase of the team by external forces has switched from 'Cross-domain R&D partnerships' to 'Enhanced cooperation with other stakeholders'.

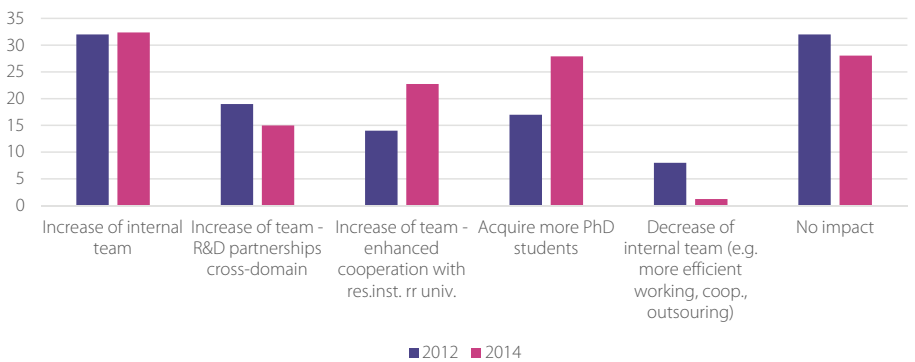


Figure 17 Impact on R&D Team Size

4.5 Impact on societal challenges

The ranking is almost the same for 2014, 2012 and 2010. Please take into account that the area 'Security & Safety' was not yet in the list in 2010. The main difference between 2014 and 2012 is the fact that the area 'Future Factories' has been ranked higher in 2014 (from 7 to 4).

The top 5 consists of:

- Security & Safety (41% of the respondents)
- Transport & Mobility (40% of the respondents)
- Energy Efficiency (26% of the respondents)
- Health & Well-being (16% of the respondents)
- Future Factories (16% of the respondents)

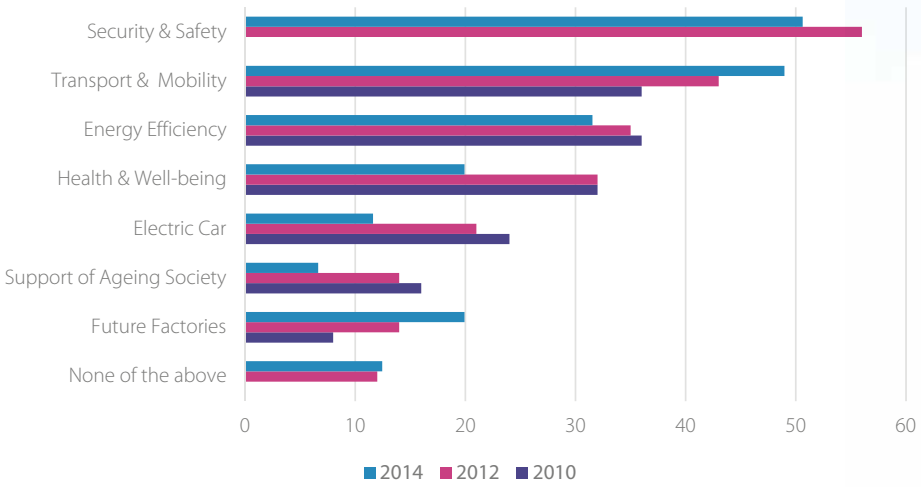


Figure 18 Societal Challenges

4.6 Conclusion on theme 2

I ARTEMIS addresses a wide range of technology and application markets. From an application point of view, automotive remains the main market addressed. The market impact mainly concerns a period of three to five years after the end of the project and shows similar results compared to 2012. Business impact is mainly on reduced development costs and reduced time-to-market as was also the case in 2012. The realisation of 'new products', however, rose from 6th position in 2012 to 3rd in 2014, at the cost of 'higher re-usability of components' (down to 4th).

II All ARTEMIS AWP targets are addressed and results are similar compared to 2012 and 2010.

III In terms of societal challenges, the top-3 remains the same as in 2012: 'security & safety'[1], 'transport and mobility' and 'energy efficiency'. The impact on 'Future Factories' has increased considerably and now shares 4th position with 'Health & Well-being' (up from 7th in 2012).

[1] *However, we still need to take into account the fact that the term 'security and safety' has a different meaning in ARTEMIS that in the overall EU policy documents. The term 'security and safety' as EU policy is much more related to global (cross-border) monitoring, prevention of terrorism and privacy of personal data. There are some aspects in ARTEMIS that hook in to this policy, such as data protection (security privacy and dependability – see ASP6), but this is limited to the embedded systems used mostly in the transport sector (e.g. rail signalling systems). As for safety, there is a risk of confusing 'safety-critical applications' (in ARTEMIS SRA) and the safety of citizens, which is the EU policy. In ARTEMIS 'security and safety' is mostly done in the sub-domain of the ASP1 (transport safety-critical applications, etc.) so, as such, one could state that it would more clearly contribute to the societal challenge 'transport and mobility'.*

Results for sub-theme 3: Successful results in the market

The questions on sub-theme 3 focus on the specific results obtained in the ARTEMIS programme, in terms of prototypes, demonstrators, tools and application products. It also investigates how ARTEMIS projects are hooked in to standardisation bodies and Open Source Communities. Dissemination and contribution to educational programmes is also examined.

5.1 Prototypes & Demonstrators

95% of the respondents indicated that they will build application prototypes. The average number of prototypes built by respondents is 2.0, compared to 1.9 in 2012. The distribution of the amount of application prototypes built is given in the chart below. It shows the amount of respondents that built 0 to 10 application prototypes respectively.

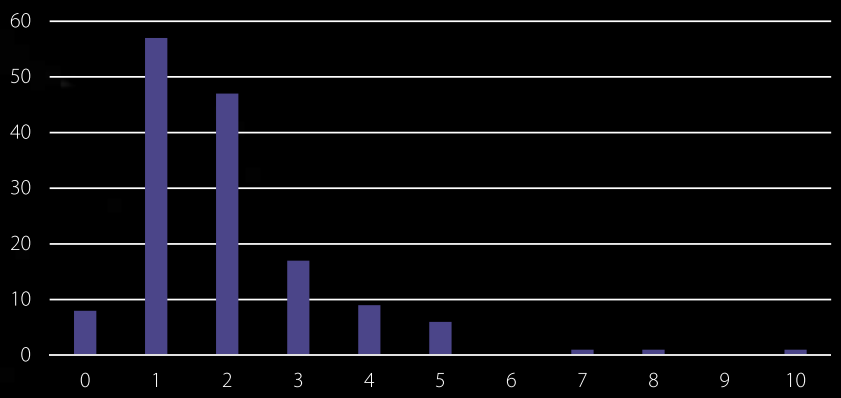


Figure 19 Amount of partners building 0 - 10 application prototypes

More details on examples of application prototypes and demonstrators are given in Annex 3.
80% of the respondents indicated that they will build design tool prototypes. The average number here is 1.3, compared to 1.8 in 2012. The distribution of the amount (from 0 to 10) of tool prototypes built by respondents is shown below.

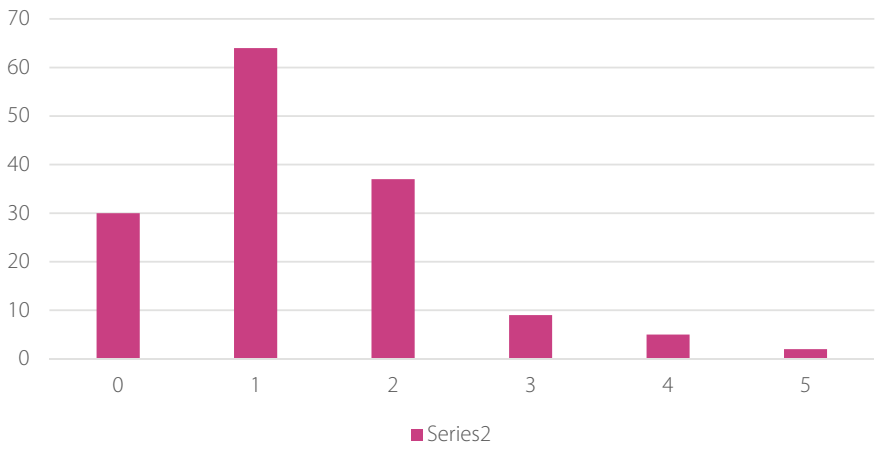


Figure 20 Amount of partners building 0-5 prototype tools

Based on the comparison between 2012 and 2014, we can see that the ARTEMIS programme is evolving more to an application programme than a tool development programme.

In terms of the dissemination of design tool prototypes, 41% plans to distribute tools to an Open Source Community, compared to 33% in 2012. The average amount of tools distributed is 1.7, compared to 1.9 in 2012. So the amount of partners distributing tools has increased and the amount of tools distributed remains in the same order of magnitude.

19% of the respondents plan to contribute to the ARTEMIS Tool Platform, compared to 29% in 2012, a steep decrease. The item requiring attention in 2012 was that 43% of the respondents did not know what the ARTEMIS Tool Platform comprises. In 2014 this figure had increased to 47%. On one hand, one has to take into account that about less than half of the ARTEMIS projects aims to build/contribute to a reference tool platform – reference design architectures in the programme. The others aim at more focused objectives such as better WSN, middleware, HMI, etc. In those cases contributions to the ARTEMIS tool platform are neither requested, needed nor relevant. On the other hand, this does remain an item where further attention is needed with respect to the strategy on Tool Platforms in the ARTEMIS programme.

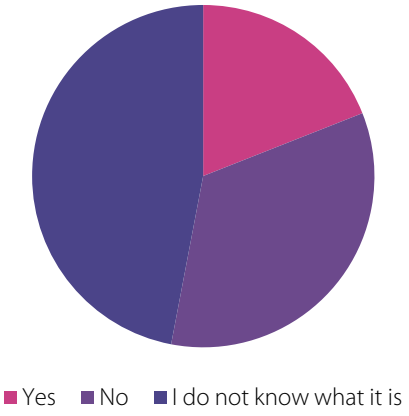
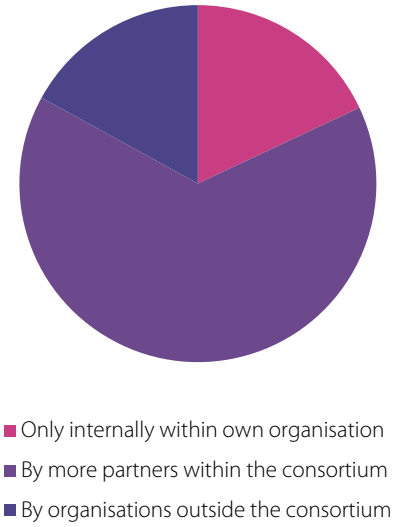


Figure 21 Contribution to ARTEMIS Tool Platform

In terms of 'tool usage' by other partners inside or outside the existing project consortium, the answers are given in the pie chart below. The distribution is similar to 2012, with a maximum deviation of 3% for each of the items.

Figure 22
Usage of tool protogypes / demonstrators



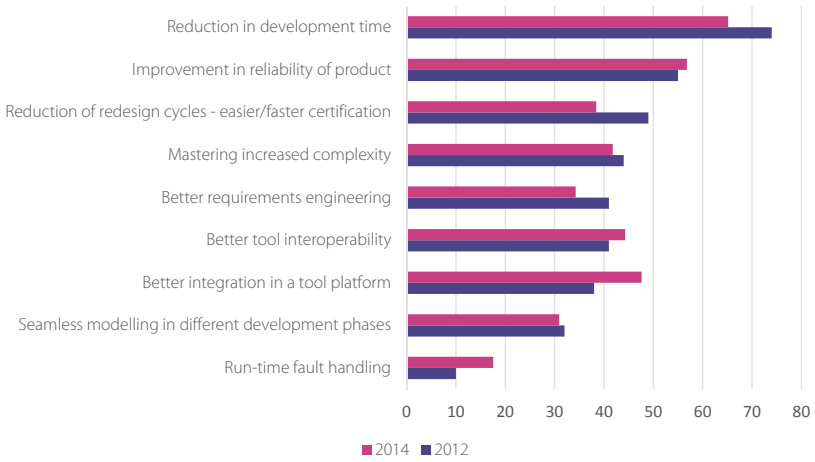
Concerning the expected improvements through the use of new tools, the outcome in 2014 is similar to 2012, with some minor deviations.

The top 3 in 2014 is:

- Reduction in development time (also nr. 1 in 2012)
- Improvement in reliability of product (also nr. 2 in 2012)
- Better integration in a tool platform (nr. 7 in 2012)

The item 'Reduction of redesign cycles', which was 3rd in 2012 dropped to 5th in 2014.
Full details are in the bar chart below.

Figure 23
Expected Improvements



5.2 Standards

The contribution to standards is declining further: from 66% in 2010 to 42% in 2012 and 37% in 2014. Most of the contribution is on the extension of existing standards and through enhanced participation in regular standardisation. The positive aspect is that the activities in standardisation are not 'business as usual' but include a higher activity level compared to 2014 for those who contribute to standardisation. In addition, 9 respondents indicated that they had created a new standard, compared to only 2 in 2012 with an equal number of total respondents.

So although the quantity of respondents active in standardisation is decreasing, the quality of the work done in standardisation is increasing.

Figure 24
Contribution to Standards

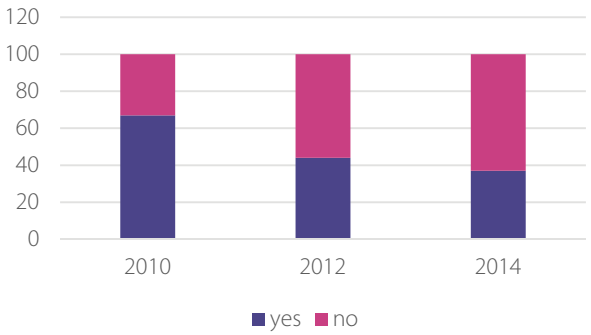
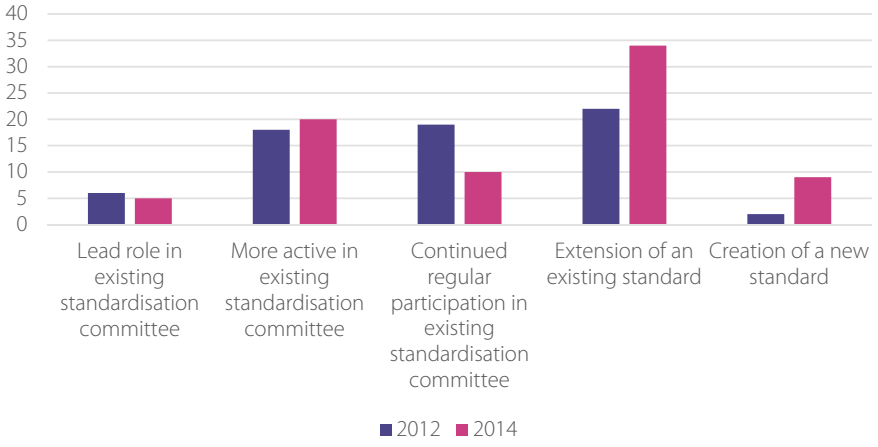


Figure 25
Contribution to Standards



5.3 Open-Source communities

- 53% of the respondents indicated that they planned to contribute to, were contributing to or had created an OSC (compared to 55% in 2012)
- 47% indicated that they were not contributing and did not plan to contribute at all (compared to 45% in 2012).

So there is no major difference between 2012 and 2014.

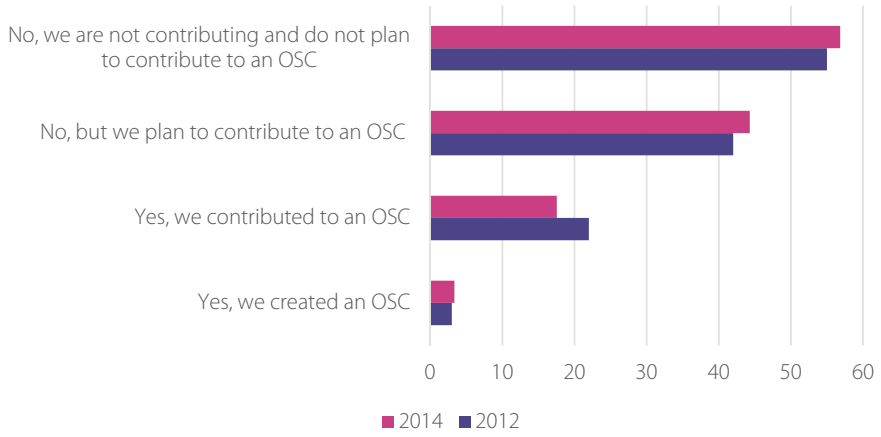


Figure 26 Contribution to Open Source Communities

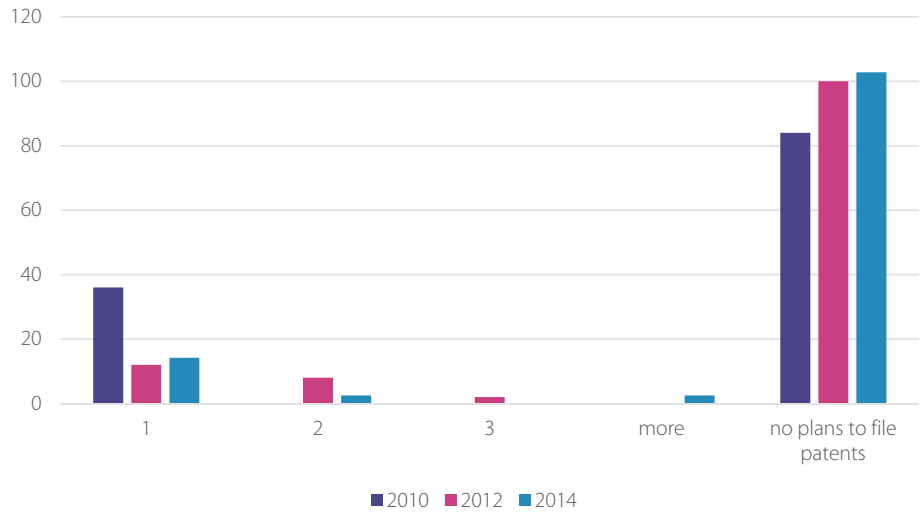
5.4 Patents

We can see that the relative amount of 'no plans to file patents' increased slightly in 2014 compared to the previous years (more than 80%). If respondents plan to file a patent, then the majority plans to have only 1 patent.

The figures below reveal the number patents filed/planned to file (horizontal axis) for the number of respondents (vertical axis). The numbers have been scaled to a factor 100, such that the difference in the total number of respondents is filtered out.

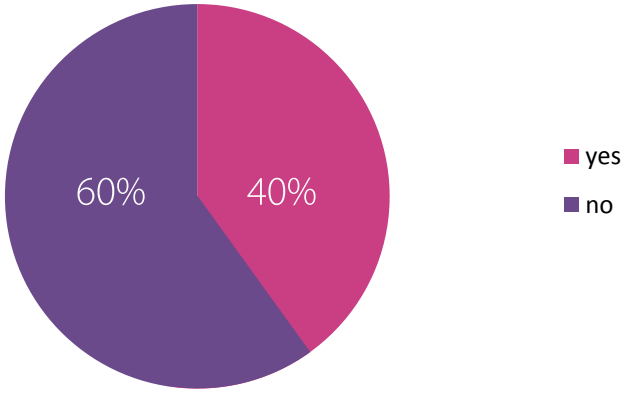
The trend of having an increase in the amount of respondents planning no patents at all is strange, as one would expect this to be an important asset for industry – which is not visible in the figures. However, one can also see that patents are expensive, time-consuming to file and that the process often takes longer than the project duration. In addition, the value of a patent as a figure of merit for this kind of market-facing research or close-to-market innovation type projects could be overestimated. Patents actually licensed is a better indicator, but is more difficult to measure and mostly happens much later than when the project is finalised.

Figure 27
Patents



5.5 Public trials/field tests

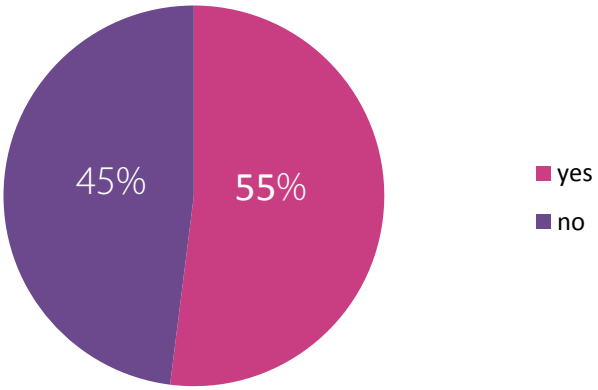
40% of the total number of respondents plan a public trial or field test. There is only a 1% difference compared to 2012.



5.6 Contributions to educational programmes

55% of the respondents plan to contribute to educational programmes (compared to 52% in 2012). As the total number of research institutes in this questionnaire is 38%, this means that there will also be a considerable amount of industrial partners contributing to educational programmes. This is a positive evolution: it proves the need to create the 'ES engineer' to better serve ES industry innovation.

Some more details and qualitative results on contributions to educational programmes are given in Annex 4.



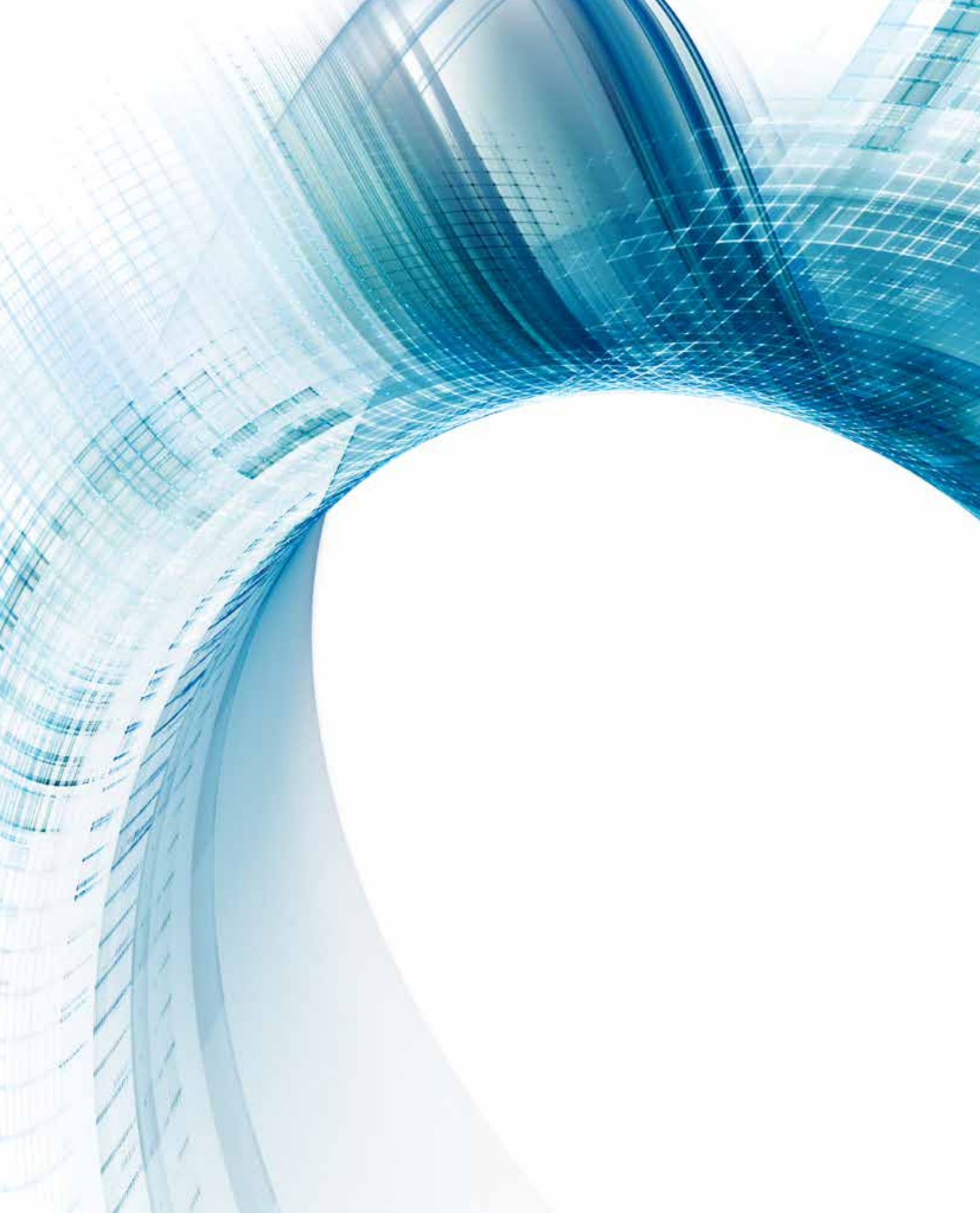
5.7 Dissemination

The table below shows the number of respondents on the different types of publications and participations in seminars and workshops.

We see a steady growth of publications and organisation/participation in workshops, with the exception of the amount of press releases, which is decreasing. So more attention should be paid in promoting the successful ARTEMIS project results by getting them published in the press and not only in specialist workshops.

Finally, there is a lot to be said for each type of dissemination but, in the end, it is the sum of the parts that counts… ARTEMIS conferences and publications have also delivered a clear focal point for dissemination of ARTEMIS results and should perhaps be even more focused and marketed in a larger way.

Figure 28
Dissemination



5.8 Conclusions on sub-theme 3: Successful results in the market

I The development of prototypes and demonstrators remains a key activity in the ARTEMIS programme. The number of partners developing prototypes and demonstrators is growing, both from an application perspective (from 70% (2012) to 95% (2014) of the respondents) as well as from a design tool perspective (from 60% (2012) to 80% (2014) of the respondents). Tool usage is 83% within the consortium and 17% outside the own consortium, which is in the same order of magnitude as in 2012. 19% plan to contribute to the ARTEMIS tool platform (compared to 29% in 2012), but 47% (compared to 43% in 2014) do not yet know what this Platform is – this remains an item for attention. The impact of the tools remains the same as in 2012, with the same 2 items at the top: 'reduction in development time' and 'improvement in product reliability'.

II The contribution to standards is declining further to 37% (compared to 47% in 2012 and 67% in 2010). Most emphasis is on the extension of existing standards and enhanced participation in regular standardisation committees. The positive aspect is that the activities in 'standardisation' are not 'business as usual', but include a higher level of activity in 2014 for those who contribute to standardisation. So although quantity is decreasing, the quality of the work is increasing.

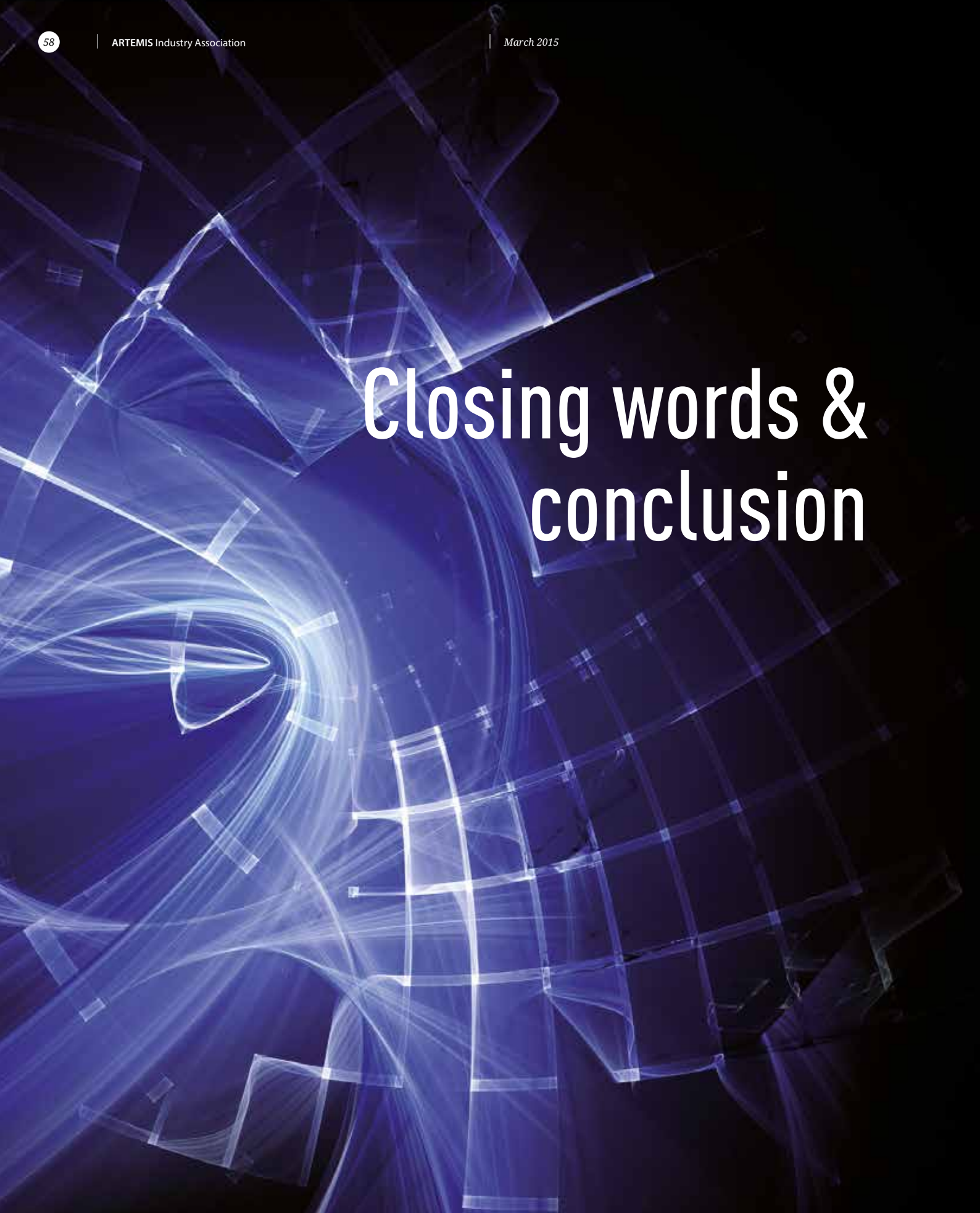
III 53% of the respondents plan to contribute to an Open-Source Community (including the creation of a new OSC), which is approximately the same as in 2012.

IV 40% of the respondents plan to set up public trials or field tests, which is at the same level as in 2012. The AIPPs remain the ideal platform to provide the scope and means in order to realise this on a larger and more professional scale.

V 55% of the respondents plan to contribute to educational programmes – this includes a large part of the industrial partners in the programme. This is a slight increase compared to 2012.

VI The amount of patents is slightly lower in 2014 compared to 2012, but with only a very minor deviation.

In terms of dissemination, the publication of books and papers, and the amount of presentations in seminars and workshops, has grown compared to 2012, while the amount of press releases has decreased slightly.



Closing words & conclusion

Analysis of the results show that ARTEMIS has been gaining momentum since 2010 and kept making progress throughout the years 2012 and 2014. Networks have been established and are fully operational. The industry-driven approach of the ARTEMIS programme does remain a key strength and motivator for the programme.

Key strengths and improvements compared to 2012 are the following:

I Involvement of SMEs in the creation of new partnerships.

II Business impact on reduced development costs, reduced time-to-market and realisation of new products (the latter having climbed considerably since 2012).

III A few key examples of major business impact have become visible.

IV ARTEMIS AWP targets are a living instrument

V Societal challenges are addressed properly – 'security and safety' being number 1. However, taking into account the security and safety focal area of in ARTEMIS (in comparison with the EU Policy), one can state that overall 'Transport and Mobility' (including the security and safety aspects) remains the key focal area of ARTEMIS.

VI Attention for prototypes and demonstrators keeps growing, including public trials and field tests

A number of items for attention still remain:

VII Uncertainty about availability of funding for all partners and the administrative burden.

VIII Alignment between EU and National agendas does require even more attention than before.

IX The ARTEMIS Tool Platform is not yet known by 47% of the ARTEMIS Community

Overall the Embedded Systems community has found its place in Europe: people are getting to know each other better, a strong link between industry and education has become visible and the quality of the technology and dissemination results is clearly visible from the results of this questionnaire. Taking into account the evolution within Europe of bringing together the ENIAC, ARTEMIS and EPOSS programmes into one ECSEL programme, one can state that ARTEMIS has definitely shown itself to be a complementary domain of expertise within the total scope of the programme, more in particular in the domain of Cyber-Physical Systems. Therefore, it is important that this field of Embedded and Cyber-Physical Systems forms a separate part in the total ECSEL agenda. In the application domains, one can look into commonalities, synergies and complementarities throughout the complete value chain (from micro-electronics devices towards fully integrated hardware/software Cyber-Physical Systems).

ANNEX 1

This annex contains the questionnaire as it was sent to the participants in ARTEMIS project

1. Please indicate what type of partner you are:

- **A.** *Large company*
- **B.** *SME*
- **C.** *University or research institute*

2. Are you the project leader of the consortium?

- *Yes*
- *No*

3. SUB-THEME 1 - How was the consortium formed? *(Please select one or more options)*

- **A.** *Through contacts in the brokerage event*
- **B.** *Through the partners search tool of ARTEMIS-IA*
- **C.** *Through the national contact points*
- **D.** *Through pre-existing partnerships*
- **E.** *Other (please specify)*

4. Did your organisation have partnerships with other consortium partners before the ARTEMIS project was proposed?

- *Yes*
- *No*

5. How many new partnerships have been created or planned between you and other consortium members?

- **A.** *0*
- **B.** *1*
- **C.** *2*
- **D.** *3*
- **E.** *4*
- **F.** *5 or more*

6. How many of these new partnerships are with an SME?

- **A.** *0*
- **B.** *1*
- **C.** *2*
- **D.** *3 or more*

7. Do you interact or plan to interact with an existing ARTEMIS CoIE (Centre of Innovation Excellence)?

- *Yes*
- *No*

8. Are you planning to create an ARTEMIS CoIE?

- *Yes*
- *No*

9. Is there any plan or intention to create one or more new companies (spin-offs, start-ups), based on the project results?

- **A.** *0*
- **B.** *1*
- **C.** *2 or more*

10. Is there an intention to continue the cooperation with the SMEs in the consortium after the project has finished?

- *Yes*
- *No*

11. Along which axis is the cooperation in the project being organised? (multiple answers allowed)

- *A. Cooperation mainly at country-level*
- *B. Cooperation mainly around the technology axis*
- *C. Cross-discipline cooperation*
- *D. Cooperation around certain application(s)*
- *E. Supply-chain based cooperation*

12. Which of the following best describes the impact of the project on the internal R&D agenda of your organisation? Please select one or more options:

- **A.** *Larger/broader R&D scope*
- **B.** *Tool evaluation & use of prototype tools*
- **C.** *Discussion about future projects*
- **D.** *Research or development partnership with other company or university*
- **E.** *New business opportunities*
- **F.** *More efficient/effective solutions or design methods*
- **G.** *Outsourcing of certain activities*
- **H.** *Increase of knowledge and/or experiences*
- **I.** *New insights on how to handle certain R&D work*
- **J.** *R&D partnerships with other companies & universities*
- **K.** *Other (please specify)*

13. Why did you select ARTEMIS as the programme to submit the project?

- **A.** *Industry-driven approach*
- **B.** *Particular technology challenges*
- **C.** *Good blend of industrial and university programmes*
- **D.** *Scope was not compatible with other programmes like ENIAC, Catrene, Itea,…*
- **E.** *Existing network of companies/universities in the ARTEMIS community*
- **F.** *Other (please specify)*

14. Did you consider submitting this project to another programme (e.g. ITEA, ENIAC etc.)

- *Yes*
- *No*

15. To what alternative programmes did you consider submitting this project?

- **A.** *ENIAC*
- **B.** *Catrene*
- **C.** *Itea*
- **D.** *FP7*
- **E.** *National / regional*
- **F.** *None of the above*

16. *What are the key strengths of participating in the ARTEMIS programme from a project perspective? Please select max. 3 answers.*

- **A.** *Partner alliances / consortium*
- **B.** *Cross-domain approach*
- **C.** *Industry-driven, industry relevance*
- **D.** *Combination of scientific and industrial views*
- **E.** *Visibility, support, dissemination & exposure of ARTEMIS-IA and ARTEMIS-JU*
- **F.** *Close to market / maturity of technological developments*
- **G.** *Short decision time & simplified application process*
- **H.** *Both national and European support*
- **I.** *Success rate compared to other programmes*

17. What are the weaknesses of participating in an ARTEMIS project? Please select max. 3 answers.

- **A.** *Long delay between submission and first financial grant*
- **B.** *Administrative burden*
- **C.** *Excessive number of participants*
- **D.** *Not well aligned EU vs. local authority administrative rules*
- **E.** *Uncertainty about the availability of funding for all consortium members*
- **F.** *Low level of financial contribution overall*
- **G.** *Large synchronisation overhead*
- **H.** *Other (please specify)*

18. SUB-THEME 2 - MARKET - What is the focal market of your project activities on Embedded System (ES) Technology Market? (Multiple answers possible)

- **A.** *ES design and test tools*
- **B.** *ES certification and validation*
- **C.** *ES software / hardware*
- **D.** *None of the above*

19. What is the focal market of your project activities on ES Application Market? (Multiple answers possible)

- **A.** *Automotive*
- **B.** *Railways*
- **C.** *Aeroplanes / aerospace*
- **D.** *Buildings infrastructure*
- **E.** *Smart grids and energy supply*
- **F.** *Manufacturing and process control*
- **G.** *Smart spaces and ambient intelligence*
- **H.** *Consumer products*
- **I.** *Medical or health*
- **J.** *None of the above*

20. In what timeframe will the project have a specific market impact?

- **A.** *1-2 years after the end of project*
- **B.** *3-5 years after the end of project*
- **C.** *More than 5 years after the end of project*

21. What will be the expected business impact? (multiple answers are possible)

- **A.** *Reduced development costs*
- **B.** *Reduced time-to-market*
- **C.** *Higher reliability*
- **D.** *Higher re-usability of components*
- **E.** *New ways of working*
- **F.** *New product(s)*
- **G.** *New generations of product(s)*
- **H.** *New market(s) being addressed*
- **I.** *Saving energy consumption of products*

22. Can you describe in short and in some detail a more concrete example of the expected business impact of the project?

(Please give some quantitative data)

23. ARTEMIS TARGETS - Please indicate the ARTEMIS AWP target(s) to which your project contributes

(multiple answers are possible)

- **A.** *Reduce costs of system design by 15% within next 3 years*
- **B.** *Achieve 15% reduction in development cycles (esp. in sectors requiring qualification/certification)*
- **C.** *Manage complexity increase of 25% with 10% reduction in effort in next 3 years*
- **D.** *Reduce by 15% effort and time required for re-validation/re-certification of systems after making changes within next 3 yrs*
- **E.** *Achieve cross-sectoral re-usability of ES devices (e.g. interoperable components for different sectors/ applications)*

24. Please give examples / explanations of the ARTEMIS AWP target(s) to which your project contributes

25. STRATEGY - What is the (expected) impact of the project on the size of the R&D teams in Europe in your organisation?

- **A.** *Increase of the team internally in the organisation*
- **B.** *Increase of team due to R&D partnerships with other industrial domains (cross-domains)*
- **C.** *Increase of team due to more cooperation with research institutes and/or universities*
- **D.** *Possibility to acquire more PhD students*
- **E.** *Decrease team (e.g. due to more efficient working, cooperation, outsourcing,…)*
- **F.** *No impact*

26. In which field(s) has the project contributed to solving the 'Societal Challenges' or to sustainability?

- **A.** *Electric Car*
- **B.** *Health & Well-being*
- **C.** *Support of Ageing Society*
- **D.** *Future Factories*
- **E.** *Energy Efficiency*
- **F.** *Transport & Mobility*
- **G.** *Security & Safety*
- **H.** *None of the above*

27. SUB THEME 3 - APPLICATION PROTOTYPES/ DEMONSTRATORS - How many application prototypes/demonstrators did you contribute to in this project?

- **A.** *0*
- **B.** *1*
- **C.** *2*
- **D.** *3*
- **E.** *4*
- **F.** *5*
- **G.** *6*
- **H.** *7*
- **I.** *8*
- **J.** *9*
- **K.** *10*

28. Can you please give some examples of application prototypes / demonstrators?

29. TOOL PROTOTYPES/DEMONSTRATORS - How many tool prototypes / demonstrators did your organisation contribute within the scope of the project ?

- **A.** *0*
- **B.** *1*
- **C.** *2*
- **D.** *3*
- **E.** *4*
- **F.** *5*

30. How many tool prototypes / demonstrators were distributed in an open-source manner?

- **A.** *0*
- **B.** *1*
- **C.** *2*
- **D.** *3*
- **E.** *4*
- **F.** *5*

31. Does your project contribute to an 'ARTEMIS Tool Platform'?

- **A.** *Yes (if yes: what did you contribute)*
- **B.** *No*
- **C.** *I do not know what it is*

32. How will the tool prototypes / demonstrators be used?

- **A.** *Only internal use in your organisation*
- **B.** *By more partners in the consortium*
- **C.** *By organisations outside the consortium*

33. What are the expected improvements through the use of the new tool(s)? (multiple answers are possible)

- **A.** *Better requirements engineering*
- **B.** *Better integration in a tool platform*
- **C.** *Seamless modelling of the product in the different development phases*
- **D.** *Better tool interoperability*
- **E.** *Run-time fault handling*
- **F.** *Reduction in development time*
- **G.** *Improvement in reliability of product*
- **H.** *Reduction of redesign cycles - easier and/or faster certification*
- **I.** *Mastering increased complexity*

34. Is there any contribution to standards? Y/N

35. What is the contribution to standards? (Multiple answers are possible)

- **A.** *Lead role in existing standardisation committee*
- **B.** *More active in existing standardisation committee*
- **C.** *Remain a regular participant in existing standardisation committee*
- **D.** *Extension of an existing standard*
- **E.** *Creation of a new standard*

36. Did you contribute to 'Open Source Communities'?

- **A.** *Yes, we created an Open Source Community*
- **B.** *Yes, we contributed to an existing Open Source Community*
- **C.** *No, but we plan to contribute to an Open Source Community in the future*
- **D.** *No, we are not contributing and we do not plan to contribute to any Open Source Community*

37. How many patents have you filed or do you plan to file?

- **A.** *We do not plan to file any patents*
- **B.** *1*
- **C.** *2*
- **D.** *3*
- **E.** *More than 3*

38. Has your organisation performed or does it plan to perform public trials or field tests?

- *Yes*
- *No*

39. Is there any contribution to educational programmes? (e.g. university courses)

- *Yes*
- *No*

40. Please specify your contribution to educational programmes

41. Dissemination of all project results (to be answered by project leaders ONLY)

- **A.** *Number of books published:*
- **B.** *Number of papers published:*
- **C.** *Number of commercial brochures:*
- **D.** *Number of press releases:*
- **E.** *Press coverage – how many articles in magazines/ newspapers:*
- **F.** *Number of seminars/workshops organised:*
- **G.** *Number of presentations with project results during conferences/workshops:*

ANNEX 2

This annex is related to questions 23 and 24 on the contribution of the project to the ARTEMIS AWP Targets (Annual Work Plan Targets) :

- **A.** Reduce costs of system design by 15% within next 3 years
- **B.** Achieve 15% reduction in development cycles (esp. in sectors requiring qualification/ certification)
- **C.** Manage complexity increase of 25% with 10% reduction in effort in next 3 years
- **D.** Reduce by 15% effort and time required for re-validation/re-certification of systems after making changes within next 3 yrs
- **E.** Achieve cross-sectoral re-usability of ES devices (e.g. interoperable components for different sectors/applications)

The participants had to choose the AWP targets to which they have contributed. They were also invited to give some additional explanation and details on how this was done. Below you can find these more detailed answers.

- Emmon has researched and created an integrated framework of technologies for LSWSN.
- Designed a new emmon Network Architecture to address scalability challenge.
- Enhanced ZigBee network protocol implementations.
- Completely new middleware which is able to cope with thousands of nodes.
- Simulation Models and Analysis tools for the Middleware.
- Emulation system to test network behaviour and system scalability in (almost) real-time.
- Advanced Visualisation Platform for indoor/outdoor environments.
- Network Planning and Deployment Tools (hw testing, Nodes programming, Network dimensioning and planning, etc).
- Reduction of the cost of re-validation/re-certification of software components when context is changed.
- Standards in Medical Informatics can increase efficacy in data treatment and reuse.
- Integrating specialised views of software development into a coherent architectural framework.
- Guaranteed traceable relationship between specification and product artefacts.
- The platform (wireless sensor network) enables interoperability with back-end applications regarding the information to be monitored through the materials flow in a production process. Also the platform is easily reused in different domains (in simple project was tested in manufacturing, logistics and home automation) thus reducing the cost and complexity for new entrants.
- Reduction of energy cost through both new device and new software tool.
- Having a common interface, different prototypes will reduce its development time and the interoperability among them will be higher.
- In our own environment there is a possibility to develop products faster and the modules can be used in several products, when the tool developed in the project can be used.
- Reduce programming effort of multicore processors.
- Reduce effort for specification, architecture design, verification and validation of embedded systems to be used in automotive, aerospace and automation industry.
- Reduction of effort required to check and coordinate.
- Reduction of effort and rework through model-driven engineering.
- Reduced effort and errors in meeting certification.
- Human Systems Integration will provide cost saving via Model Based System Engineering.
- Development of MBSE.
- Introduction into Variability Management.
- Design Space Exploitation.
- Safety Analysis.
- Holistic & Simulation.
- Multi-viewpoint Engineering.
- Maritime surveillance systems.
- Portable pilot units.
- Reusable building blocks for multicore image processing leads to easier development, shorter development times and reuse, enabling the development of more complex systems. Some of these more complex systems were prototyped or built during the project life-time.
- A model-driven process for the compositional development of safety and security for critical global multi-systems/system/distributed system/system of systems including multi-physics systems.
- Analysis methods to verify the claimed assurance level of trusted environments.
- Processes, methods, techniques and tools that support systems of systems design and allow design trade-offs between aspects of autonomy, evolvability, resilience vs. strict predictability and dependability.
- Processes, methods, techniques and tools that support systems of systems certification.
- Developing methods and tools supporting the move from system architectures consisting of a set of loosely

coupled or hierarchical control systems, towards more distributed control and peer-to-peer architectures, with a particular focus on guarantees of safety relevant properties.

- Enabling an increase of cross-domain re-use and interoperation, thus leading to lower costs of ownership and wider applicability. We re-use modules and expertise and we create general module components common to many applications. The project will raise the level of abstraction at which the execution platform can be considered by application designers and mix open source and proprietary software embedded systems, normally robot systems.
- Usage scenarios taken from ap2, asp3, and asp6; including coverage of asp8 regarding human-centred design of human-machine interfaces and, particularly, object recognition, scene analysis, real-time image processing, and cognitive assistance.
- Possible standardisation of artefacts in design/ requirements management for reuse.
- Reduced development effort and faster time-to-market due to early system-level modelling and exploration.
- Autonomous vehicles in rural areas.
- Product development time cut down with new design space exploration methods.
- Reduce system design cost: by means of specific component reusability the overall design process cost reduces dramatically.
- Development cycle reduction: even specific component develop time has been increased, as component reusability has been assured, the developing time for the next project based on component reusability reduces the whole development time.
- Re-validation and re-certification processes: by means of our new development life cycle based on component reusability assurance, the aforementioned processes have been reduced by 15%. For auto domain, the main targets concern the performance aspects.
- We contribute to lower development time by improved mechanisms of integration.
- Saving time at company level through a Reference Technology Platform for which the project was an enabler, at the local production sites due to integrated specific tool chains and improvements of various tools / development phases / certification.
- Higher confidence in high level phases (e.g. requirements) is essential to build safe systems.
- During the course of the project, the use case description will be refined in order to resolve the targets of the work package. The work package will also provide and implement solutions which then will be forwarded to the Interoperability domain and will have a strong interaction with the Aeronautics domain use case. Results of the wireless sensor network guarantee future applicability to other aeronautic vehicles (launchers) or even to commercial and military aircraft.
- Benefit beyond specific use case are:
  - Recognition of environmentally resistant problems,
  - Recognition of problems with wsn in metal environment (Rail domain useful)
- Our tools allow testing time to be reduced by a factor of 10 to 20, at the same time as that we find more faults and have a stop criteria for testing aligned with certification.
- Testing is 50% of the total development cost. Thus, we help reduce the overall development cost by reducing the testing cost.
- The overall model-based analysis and test combination methodology for Embedded Systems supports all.
- Increased complexity of data management facilitated by the development of context reasoning engines.
- Reduction of human effort thanks to the use of contextual sensors.
- In the smart city and transportation sector exploitation opportunity will be investigated for component-based development using pre-certified components, component reuse across domains for multi-purpose industrial robotic platform reduction of design time.
- The project directly links to the Artemis industrial priority reference designs and architectures mainly in smart spaces, smart cities and large deployments of control-based motes.
- The Encourage middleware is using standardised data formats and interfaces, which support interoperability with other domains.
- Secure stable energy supply and transition to green sources.
- The project has a separate Interoperability sub-project in which all the domain-specific technology is mapped and cross referenced against each domain to find cross-applicable solutions.
- An example is to provide tools and methods that can ease the formalisation of safety requirements, thus making it simpler (and less time-consuming) for the specifier to do this formalisation.
- Interoperability framework in the Energy domain.
- We manage to reduce the time-to-market by 15% when we used the developed techniques.
- Our contribution is low-level software targeted to secure execution and could be applied to many application types.
- Our own developed hypervisor which targets high-level

certification based on formal methods has the possibility to be a very cost-efficient software layer with a potential huge future market.

- Communication protocol implementation.
- Crystal ios and management utilities of RTP will:
  - improve allocation of functionality, risk and cost of a whole system by breaking up engineering silos (mechanics, electronics and software will fuse, other categories of division will emerge) -> reduction of engineering cycles
  - new ios features will simplify effective manipulation of logical objects in projects -> reduction of development time during engineering activities
  - user/engineer designed automation with a clear reuse strategy will introduce a clear trend to engineering whole systems and the base of 'continuous delivery' whereby the tool chain adheres to high-level spice model categories (monitored, self-optimising processes in tool chains) -> Reduction of cost and efforts because tool chain and methodology can more naturally grow for complex products ('open headroom')
- By developing a common architecture for handling ADAS it simplifies the development and the availability of common parts permits the reduction of the validation time, too, other than improving interoperability among systems of different suppliers.
- On the product development part related to optimised application mapping to embedded processors the project does actually much more than the targets specify. The experimental evaluation provided evidence of the strength of our design automation tools in lowering the development effort and shortening the design time by a multiple factor (more than 100 on the tested cases) while automatically synthesizing designs of comparable (or higher) quality to the hand-made designs. Through enabling the creation of high-quality products several times faster and cheaper, the project makes possible the management of a complexity increase by a significant amount with a huge reduction in effort, and substantially increases the (re)usability of embedded processors for different sectors/applications.
- Real-time software testing time is essentially reduced.

ANNEX 3

This annex is related to the questions 27 and 28 on the application prototypes and demonstrators built in the projects and the list below contains some examples from the projects.

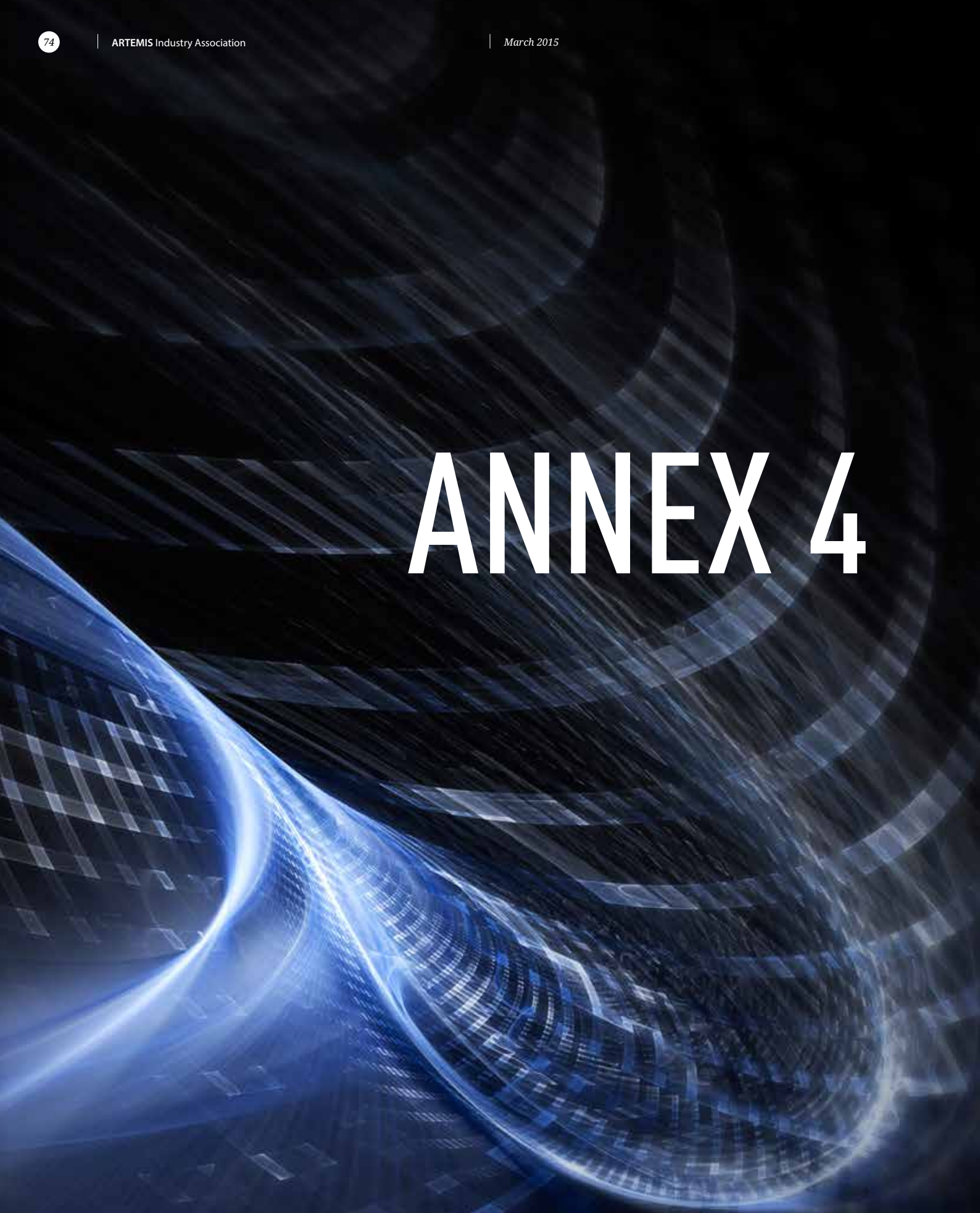
- Demmon1 was - at the time - the largest single-site wireless sensor network deployment in Europe for R&D purposes (2010) and was composed by +300 nodes and integrated all system components of the architecture. It was delivered in a test environment in Portugal.
- Demmon2 is again the largest single-site wsn network deployment in Europe for R&D purposes (2012). Demmon2 is composed by +400 nodes and integrates all validated EMMON system components. It is deployed in a live end-user site in Portugal, and addresses the Smart Buildings domain (Energy-efficiency)..
- Healthcare: Defibrillator Use Case.
- Dual Standard Translator.
- Middleware for data transmission from home to hospital and vice versa.
- Risk assessment modules for petroleum industry.
- Augment the AUTOSAR-driven development with capabilities for integrating heterogeneous specifications and for optimising code mapping to multicore processor.
- Allocation and timing properties verification of an aerospace application model
    1. Simple generic wireless sensor network platform
    2. Simple prototype application for manufacturing
    3. Simple prototype application for logistics
    4. Simple prototype application for home automation
- Approach Stabilisation Advisory Assistance system in aeronautics domain.
- Evaluation of swarm of unmanned vehicles.
- Assistance system for safe breathing.
- Demonstration of wsn application in railway. Development of wsn for monitoring train integrity driver support.
- Energy monitoring in cars in context of energy (charging) chain.
- Security link layer prototype based on 802.15.4 standards.
- 3d localisation, mobile maintenance, energy efficiency through system collaboration.
- Prototype implementation of Air Traffic Management middleware. Ultra Wide Band (uwb) technology for short range communications and indoor positioning.
- Industrial and Intelligent Transportation Systems. Image and video processing and delivery.
- Specify embedded systems in SysML language and verify design correctness by mapping SysML description to timed automata.
- Model-driven systems engineering.
- Change Impact Analysis.
- Verify requirements.
- Operator adaptations for control room and border security applications.
- Vessel Path Planner.
- EEG-MRI combination.
- Several improvements in MRI image quality.
- Workflow support through mobile access to medical images.
- High distribution rate for images.
- The project features four dedicated living labs (industrial robots, professional service robots, field robots and flexible re-configurable mobile logistics robots), each fostering at least one, typically 2-3 dedicated demonstration platforms. All of them were contributed to via our dedicated 'design and development tools' work-package as well as our second main focus, the design of the high-performance embedded computing platform comprising reusable hardware and software components. Also, an own dedicated demonstrator was originally planned featuring swarm robots, which had to be scrapped due to the absence of national funding.
- X-by-wire.
- Assisted parking application.
- There was another application planned, on air quality monitoring, but the SME that was providing it went bankrupt (among other factors) due to the Italian government delay in signing the national contract. We are scrambling to find a replacement (for free, i.e. without any funding in sight).
- Framework for requirements management (definition, verification, testing, validation).
- Demonstration of early-phase exploration of execution platforms for video processing.
- Remote controlled full-size car, as a development platform for a fully autonomous car.
- PragmaDev Tracer.
- Brake-by-wire.
- Hybrid car power management Powertrain.
- Fly-by-wire.
- Flight Warning System.
- Turn indicator.
- Helicopter stability testing environment in the automotive domain.
- Control Room Software.
- Seismic processing.
- Embedded MIMO radar platform.

- AED: Automated External Defibrillator task has been deeply analysed by means of two preliminary software releases that have shown the key benefits of a component-based development approach.
- The application implemented on my demonstrator vehicle is the Lane Change Assistant (lca), which provides complete support for lane-change and overtaking manoeuvres and, where this is not possible, assistance for longitudinal driving task (Advanced Front Collision Avoidance).
- We demonstrated an integrated, smart system that supports diabetes patients in their daily healthy behaviour using multiple systems that work in a coordinated way together, with input from an artificial intelligence system.
- A Virtual Human Centred Design (Virtual hcd) Platform, to be used for the design of future adaptive and cooperative driving aid systems.
- Building a comprehensive RTP was already a demonstrator in itself. Demonstration of validated key concepts of modular certification was innovative and challenging.
- Aerospace demonstrator.
- Embedded µController System.
- Time-of-Flight Image Sensor.
- By removing wires and using SpaceForest wsn (Wireless Sensor Network) the weight reduction of
  - aeroplanes,
  - helicopters,
  - satellite launchers
  - others

  will be obtained.
- SpaceForest Rocket Demonstrator of DEWI Aeronautics Domain can be used for the other applications such as a research rocket.
- Data/Time-flow Simulation for distributed Embedded System in a car using bus-based communication.
- Fault-oriented test case Generation for, e.g. Train control system.
- Robotics Web Services HMI.
- Robot Integrated drives.
- Hybrid Power control unit, Turn Indicator, Brake-by-wire, wireless sensor module incl. positioning aspects.
- Automotive and aeronautics infotainment systems. Residential building and manufacturing plant management.
- Emergency dispatching management.
- Asset & Consignment Tracking System in the logistics chain.
- Multi-purpose industrial robot - mobile robot aircraft fuel management system (more precise lateral and vertical navigation).
- Demonstrator for driver assistance systems.
- We will contribute in the area of algorithms development based on laser sensors with the aim of positioning and identifying 3D patterns and defining tool interactions with real objects compared with those patterns.
- One is a smart parking place (Madrid, Spain), the second is an air pollution control system (Torino, Italy).
- Human energy expenditure estimation.
- Medical decision support system.
- Supervisory control of the energy consuming/producing devices in a domestic building.
- Flexoffer prototype, demonstrating a generic way for a device to display and communicate its flexibility available for smart grid purposes.
- The demonstrators are still to be planned. The expected demonstrator will feature a system capable of remotely monitoring facility conditions, doing adjustments to the conditions, planning maintenance actions and providing precise data to the facility owner for decision making.
- Tool for the formalisation and verification of safety requirements.
- EV charger spot for domestic applications.
- EV charger sport for external and remote applications.
- Software support for diabetics to postpone the intake of insulin by adhering to a healthy life style.
- Design patterns for cooperation, state inference and multimodal user interfaces were used in all prototypes.
- A streamline, cost-saving tool chain that shortens the development time from 'large' to 'nothing' by using automation. Also cost reduction with quality increase is radical. This is demonstrated via tool chain from several partners.
- UAV demonstrator for swarm operation.
- Multi-resources smart meter based on EU energy standards.
- We made a tool and we made a pilot implementation in one city.
- Digital persuasive health assistant.
- Our contribution assure security in the start-up sequence of an embedded node including a hypervisor contributed by another partner that participated in the project.
- Demonstrator 'i' (Erlangen) in close cooperation with Siemens the specification of the communication protocol of the energy storage system.
- Adapter for interoperability
- We supplied an ADAS system in the novel architecture to be installed on a demo vehicle supplied by another partner. Our system cooperates with the one supplied by

the other partner to supply a more complete function.

- District heating.
- Maintenance information in mobile machinery pilot installation (discrete processes); pilot installation (process industries); university demonstrator (lab installation).
- Optimising the use of several energy sources for a lift, including batteries, solar panels and energy recovery systems.
- Factory line demonstrators.
- The nSHIELD General Framework consists of four layered system architecture and an Application Layer in which four application scenarios are considered: 1) Railway, 2) Voice/Facial Recognition, 3) Dependable Avionic Systems and 4) Social Mobility and Networking. Each application scenario involves several prototypes developed or modified in the project framework. Up to 40 single prototypes have been studied.
- Intelligent cockpit.
- Emergency dispatching.
- Automotive infotainment.
- 2x Highly Automated Vehicle.
- Autonomous vehicles that move goods and act as a link between different stations (e.g. palletising systems, high bay racking and loading platform).
- Service robots aimed at providing services to humans (e.g. to autonomously carry out dangerous or tedious tasks).



ANNEX 4

This annex is related to the questions 39 and 40 on the contribution of the participants and projects to the educational programmes. The list below gives some examples on what has been contributed to specific education programmes and institutes.

- We have created educational material and a Use Case to use with the Embedded Systems Master certified safety manager training integrated in university courses.
- PhD and Master theses, some lessons in the framework of a Master Course.
- The prototypes will be presented in our courses.
- Most of the lessons learned through the project will feed the syllabus of:
  - software engineering
  - concurrent and distributed systems
  - real-time embedded systems

  in our computer science curriculum.
- Bachelor and Master theses, PhD thesis.
- Support for PhD thesis.
- Improvements to study courses.
- Discounts of up to 70%.
- Teaching at universities.
- Arrowhead Framework has been introduced into MSc curricula.
- Modify curriculum to include courses in Embedded Systems Design with practice on tools used by industry.
- Cross-EU funded programmes.
- Lectures and lab courses.
- Sponsoring industrial PhD student.
- Contribution to some university scholarships.
- We offer courses at one university. Our tools are used on several advanced courses on ES throughout the world.
- Use cases from the project can be used as application examples in courses.
- Guest lectures and workshops at various universities. Also close cooperation during the project with a PhD student and university internees that worked at our company for 6 or more months on this project as part of their graduation work.
- Master Degree courses, French Doctoral School Training, PhD training, ITN/Marie Curie projects, international educational partnership with European and US universities.
- Given invited lectures for Bachelor and Master students presenting our research. Two Master theses and two PhD theses have used and contributed to results.
- Specific lectures in Master-course 'Safety & Systems Engineer' of High School Campus Vienna (starting 2015).
- Politecnico di Milano has used the outcomes of the project in its courses.
- Advanced topic is verification.
- Test and verification of software.
- Masters course on Component-based Software Development.
- The demonstrators are also included in my lectures.
- Educational use case and training material.
- Supervision of Masters work.
- We include the knowledge acquired in a course entitled 'Wireless Sensor Networks' of the Master on Industrial Electronics of Polytechnical University of Madrid. We also provide a seminar on this topic in a Master on Electronic Systems at Universidad Carlos iii de Madrid.
- The developed platform is used in student projects.
- Some of the know-how achieved through the project may be used for teaching in some courses in our university.
- Aalto University special industry lecture for course:T-86.5141 Enterprise Systems Architecture https://noppa.aalto.fi/noppa/kurssi/t-86.5141/etusivu.
- We participate as guest speakers through university lectures.
- Master course Ergonomics, Master course Mechanical Engineering at TU Munich.
- Lectures at Delft University of Technology.
- Inclusions to the existing courses, new line of Master projects.
  - course at our university in collaboration with and technology usage of one of the project's industrial partners;
  - several PhD and MSc projects performed/ being performed in relation to the project;
  - several traineeship placements of PhD students by one of the project industrial partners;
  - two tutorials on the project results: in the framework of date conference and summer school;
  - numerous papers in international conferences and journals.
- Modelling in Mathlab/Simulink environment: University Master level programme with colleague who participated in the Artemis project also active at the faculty.
- University of Applied Sciences, training courses and seminars on formal methods, testing, functional safety & security.

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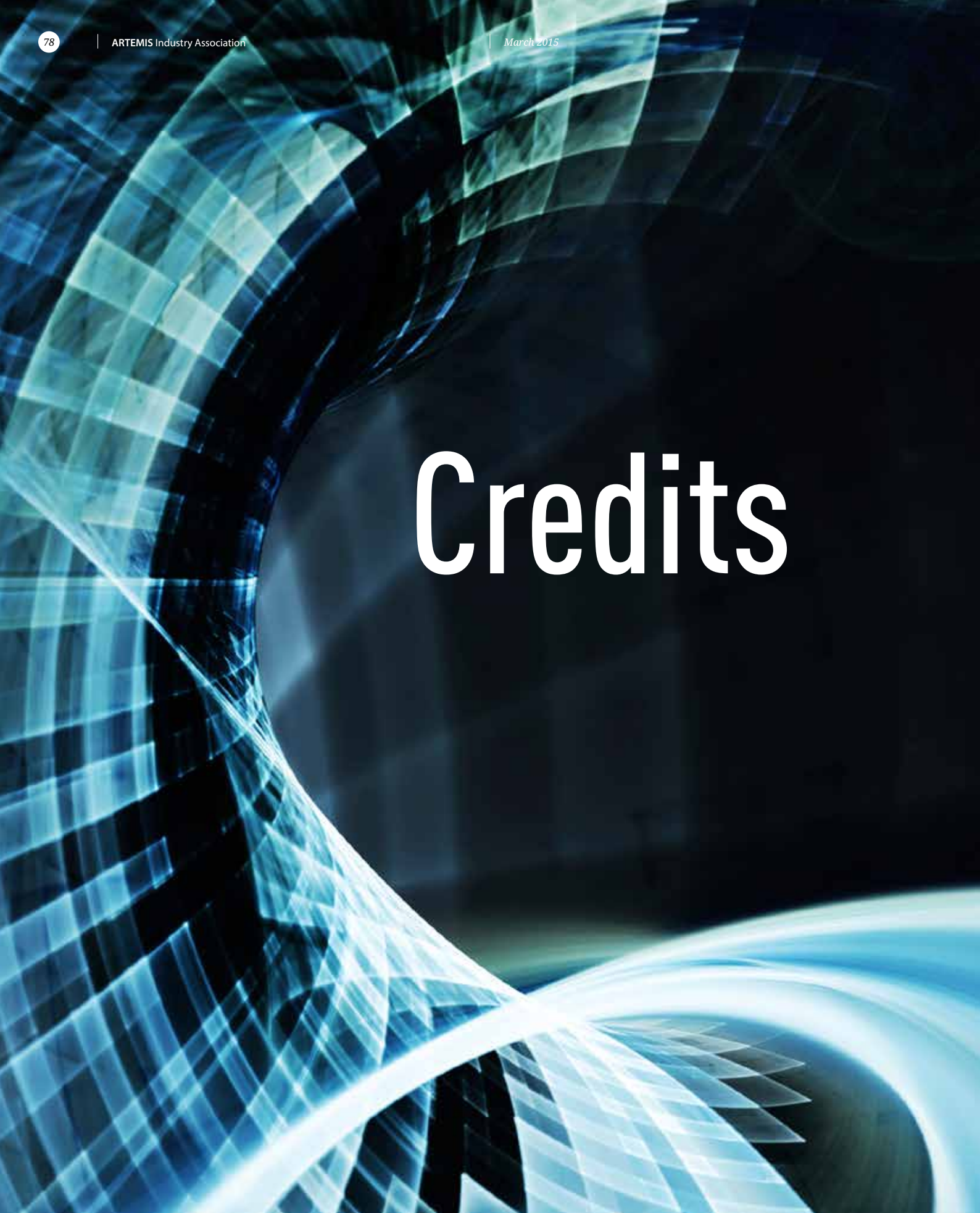

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