Cyber-Physical Systems Engineering Labs

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3rd Open Call for innovation projects

www.cpse-labs.eu

CPSE Labs is part of the EU-funded Smart Anything Everywhere Initiative, which aims to generate new and breakthrough technologies, boost competitiveness, create jobs and support growth in Europe. We invite technology and engineering firms to submit proposals for industrial experiments to develop innovative cyber-physical products and services. Successful proposals will receive both funding technical support.

Call opening:	April 27th 2016
Call deadline:	June 22nd 2016: 17h00 (Brussels time)
Proposal language:	English
Project length:	9 to 12 months (end by 31-10-2017)

Details

- Proposals should respond to one of the topics in this call document.
- Funded experiments will be carried out by the successful applicant(s) in collaboration with at least one CPSE Labs Design Centre. Successful proposers will receive funding as well as support, training and expertise.
- Proposers should use the proposal template when writing their proposals. Important guidance is included in the proposal template, as well as in our FAQs. Both are available from: http://www.cpse-labs.eu/downloads.php.
- Completed proposals should be submitted via email to open-calls@cpse-labs.eu before June 22nd 2016, 17h00 (Brussels time).
- Proposers may submit a draft proposal to service@cpse-labs.eu for a pre-proposal check up to one week before the deadline (by June 15th 2016 at 17h00 CEST). Pre-proposal checks provide feedback on the scope and eligibility of proposals. Note that advice provided is strictly informal and non-binding and does not engage the CPSE Labs with respect to acceptance or rejection of a proposal.
- Any organisation eligible for EU support is very welcome to apply. Proposals from SMEs or organisations new to EU funding are particularly welcomed. Costs will be re-imbursed to industrial applicants and profit organization at the rate of 70% (including direct costs and 25% for indirect costs) and to non-profit at the rate of 100% (including direct costs and 25% for indirect costs).
- More details on our process and eligibility criteria are available at www.cpse-labs.eu. Applicants are encouraged to contact our service centre (service@cpse-labs.eu) or any of our partners for more information.

The CPSE Labs project is co-funded by the European Community's Horizon 2020 Programme under grant agreement no. 644400.

Call Topic – Third CPSE Labs Open Calls

Call Topic	Safe autonomous vehicles
Topic ID	16-FRA-01
CPSE Labs Design Centre	France
Indicative Budget	€ 270,000 to be distributed between 3 - 4 experiments
Experiment's duration	9-12 months and ending before October 31st, 2017
Type of Experiment	Transfer to new use case Value chain completion

Overview

This call targets experiments to transfer or extend innovative approaches of realizing safe autonomous vehicles. Such systems have the potential to revolutionize areas like public transportation, manufacturing, domestic services, rescue operation, agriculture and mining. However, a pre-requisite to their widespread deployment is their compliance with high dependability requirements, including safety-critical ones.

Specific Challenge

CPSE Labs France aims to make dependability technologies affordable for companies that are developing autonomous vehicles, e.g., mobile ground robots, UAVs or intelligent cars. To serve this aim, the Design Centre provides several methods on tools as described in the following section.

The call is in direction to various categories of partners: (i) technology users, for experiments aiming to transfer and assess the above technologies by applying them to critical use cases; (ii) technology suppliers, for experiments aiming to consolidate and extend the set of methods and tools available for building safe autonomous vehicles. Experiments involving both technology users and technology suppliers are also welcome, in order to establish new partnerships for the integration of products or services for autonomous vehicles. Experiments enabling an increase of technology readiness level of results achieved by former CPSE-Labs experiments are also encouraged.

Design Centre Support

The experiment is jointly supported by the French and the Swedish Centres (with no incurred cost to the experiment). The French Design Centre provides the experiment with expertise and services and also with access to the following technology platforms

- For system dependability analysis – HAZOP-UML is a model-based safety analysis method to identify operational risks due to human-robot or robot-robot interactions. AltaRica-based analysis allows the assessment of a candidate architectural solution, with an allocation of safety levels and budgets.
- For safety enforcement – SMOF is a Safety Monitoring Framework to derive the specification of a set of safety monitors that launch safety interventions when dangerous states are detected. The synthesized strategies ensure safety while minimizing impact on the functional activity of the system.
- For rigorous software engineering – GenoM and MAUVE are two model-driven, component-based frameworks for developing robotic software functions. GenoM is compatible with mainstream robotic middleware (PocoLibs, ROS, Orocos). It has gateways to tools for formal verification at the

model level (see in particular the on-going experiment to integrate GenoM and the BIP formal framework, http://www.cpse-labs.eu/ex_c1_fr_v&v.php). MAUVE is compatible with Orocos/ROS. It comes with formal verification at the code level, using code instrumentation and verification of timed execution traces.

- For Software-In-the-Loop testing – MORSE is a generic simulator for robotics based on the Blender Game Engine. The MORSE-based test method provides a framework for the generation of virtual worlds and missions, allowing robots to be tested in a variety of situations. This framework may be adapted and extended to other robotic simulators allowing software in the loop testing.

The Swedish Centre provides complementary European expertise about the technologies and markets for autonomous vehicles.

Proposals should indicate the desired types and level of support required:

- Hosting of experiment meetings.
- Training on the technology platforms.
- Collaborative Project Work to assist with focused activities that may include:
    - Scoping of use cases and demonstration artifacts
    - Surveys and background research
    - Technical work on the methods and tools
    - Communications support

Expected Results

The expected results depend on the category of experiments.

For experiments applying existing technologies to a new use case:

- Each transferred technology shall be illustrated on artifacts derived from the use case that are representative enough but do not raise IP or confidentiality issues. These outcomes shall be in an easily understood way and available for later demonstrations at the Design Centre.
- The experiment results shall describe what was valuable for the use case, what were the difficulties encountered, and possibly suggest future direction to resolve these difficulties.
- The results must be summarized in a publishable experiment description document.

For experiments aiming to develop new technologies or services, or to work on their integration:

- Each experiment shall provide a suitable demonstrator, which illustrates the created benefit in an easily understandable way and is available for later demonstrations at the Design Centre.
- Achievements must be compared to the situation preceding the experiment, where possible on the basis of measured values from industrial applications.
- The results must be summarized in a publishable experiment description document.

Expected Impact

The results gained from the experiments shall be taken as starting point for the development of new products or services supplied to customers or directly transferred and applied for industrial use.

Call Topic – Third CPSE Labs Open Calls

Call Topic	New Cyber Physical e-Navigation Solutions
Topic ID	16-GERN-01
CPSE Labs Design Centre	Germany North
Indicative Budget	€ 90,000 for 1 experiment
Experiment's duration	9-12 months and ending before October 31st, 2017
Type of Experiment	Transfer to new domain Value chain completion Transfer to new use case

Overview

This call addresses experiments regarding the development, test, validation and/or verification of new e-Navigation solutions based on an e-Navigation testbed.

Specific Challenge

The maritime domain historically comes from paper charts. Significant new business opportunities arise by using information technology that enable the digital transformation of the maritime sector. The Automatic Identification System (AIS) and Electronic Chart Display and Information Systems (ECDIS) have been one of the first famous systems that make use of information technology to enhance maritime safety. Furthermore, the IMO with its e-Navigation Strategy goes towards a new harmonised information exchange between the several maritime stakeholders to make maritime transportation safer and more efficient (MSC85-26, Add. 1, Annex 20, 2009).

New systems supporting this e-Navigation strategy such as new Integrated Bridge Systems (IBS) or networked Vessel Traffic Service Systems (VTSS). This new generation of Cyber-Physical Systems (CPS) is transforming the way humans and machines (like ships) interact with the physical world and by this will have strong influence on the future of navigation. However, the development, testing, validation and verification of new e-Navigation solutions usually causes huge efforts due to the need for testing infrastructure, deployment of test systems and sea trials.

With the e-Maritime Integrated Reference Platform (eMIR, www.emaritime.de) the Design Centre Germany North provides a testbed for e-Maritime and e-Navigation solutions. This platform consists of the simulation environment HAGGIS that can be used for early simulation based development and testing as well as of the physical testbed LABSKAUS installed at the Germany Coast. HAGGIS comes with a number of simulators: Maritime Traffic Simulation, Sensor Simulators, Environment Simulators, and a cognitive human behaviour simulator. LABSKAUS provides a mobile bridge, an experimental VTS, a research boat with sensor equipment (AIS, radar, D-GPS, compass, LTE), shore based sensor stations (radar, camera, wind) located in Cuxhaven and Brunsbüttel and data exchange components for information exchange and cooperative decision making between ship and shore.

Furthermore, the testbeds are underpinned with methods for architecture development (the Maritime Architecture Framework, MAF) to support the realization of interoperable systems and services.

The objective of experiments within this call is to use this testbeds for the development and early testing, validation and verification of new Cyber-Physical e-Navigation solutions. Such solutions can be (amongst others):

- New sensor technology like LIDAR for distance measurement for navigation and collision avoidance
- New assistance functions for collision avoidance, berthing, tug operations, automatic navigation

- New assistance functions for manoeuver execution
- Data exchange functions for cooperative navigation in dense traffic areas (ship/shore, ship/ship data exchange)

Experiments shall describe a new e-Navigation solution that will enhance safety and/or efficiency of maritime traffic and how this new solution shall be tested using the eMIR platform. The relevance of the e-Navigation solution with respect to the e-Navigation Strategy Implementation Plan shall be described. Furthermore, the expected benefit (costs, resources, time) of the availability of a maritime testbed compared to the development without a testbed shall be assessed.

The solution developed in the experiment shall either

- Use existing knowledge from another domain and bring it to the maritime domain (e. g. transferring knowledge about collision avoidance in the avionics domain to the maritime domain) or
- Create new vendor-supplier relationships to create new products (e. g. embedded system controller supplier and INS vendor working together in a consortium to develop new navigation equipment) or
- Use existing knowledge and bring it to a new use case (e. g. LIDAR distance measurement for collision avoidance on high sea or for berthing operations)

Design Centre Support

For the experiment, the Design Centre North provides access to the components of the eMIR platform and will execute workshops together with the experiment partners to support them with the usage of these components.

The Design Centre North will support and consult experiment partners to adequately gather the information expected in the call. Furthermore, the design centre will coordinate alignment between the applying experiment partners and consortia/partners of already running experiments to enable later on interoperability of experiment solutions.

Expected Results

The experiment shall produce new cyber physical e-Navigation solutions that have been tested and demonstrated using the eMIR platform. A report about the benefits of the using the testbed for the development and testing of the e-Navigation solutions shall be provided. Furthermore, an analysis about possible future improvements and extensions of the existing testbed to optimize it towards the needs of the maritime industry shall be conducted and documented.

Expected Impact

The results gained from the experiments shall be taken as starting point for the development and/or demonstration of new products or services supplied to customers or directly transferred and applied for industrial use.

The experiment will be used to identify needs for improvements to better fit the needs for testing, verification, validation and demonstration using this testbeds. From this improvements the whole maritime domain will benefit, in addition the demonstration will transfer the knowledge about this platform and by this lower the entry barriers to use this platform.

Call Topic – Third CPSE Labs Open Calls

Call Topic	CPS technology for the citizen
Topic ID	16-SPA-01
CPSE Labs Design Centre	Spain
Indicative Budget	€ 104,000 for 2 experiments (approx. € 50,000 each)
Experiment's duration	9-12 months and ending before October 27th, 2017
Type of Experiment	Value chain completion Transfer to new domain

Overview

Adoption of CPS technology in the citizen environment finds a number of barriers that we will try to overcome with the proposed experiments. On one hand, the goal is improving existing business models using this technology, thus proving how its adoption can improve existing business opportunities (Challenge 1). On the other hand, the goal is developing new business opportunities by adopting solutions that have been proved either in lab conditions or in functional domains other than the citizens' (Challenge 2). In both cases, a clear improvement of TRL is expected; and business plans for the commercial use of the results must be provided.

Specific Challenge

Challenge 1: It is oriented to the improvement of already existing business opportunities by the enhancement/completion of business opportunities using CPS systems.

CPSs have proved to have a high potential to improve business processes that require automation, heterogeneous systems integration and huge volumes of information management. However, their implementation in real conditions within smart cities is still limited. Restrictions include poorly adapted infrastructure, limitation in deployed sensors, use and maintenance complexity, lack of use cases with a high business impact, etc. A detection of weak points in different business models using CPS technology requires:

- A clear definition of the existing business model.
- The identification of improvement points.
- The proposal of a technology that optimizes the weakest points.

We can find multitude of application cases, from which we can mention:

- Improvement in the public resources' use efficiency.
- Exploitation of synergies in the management of related infrastructures, such as in energy.
- Waste management.
- Environmental and emissions levels monitoring.
- Logistics and retail.
- Optimization of local business models such as tourism.

Challenge 2: The goal is bringing the technological progress achieved in laboratory or in different functional domains to the citizen environment.

There are plenty technological progresses in the CPS field that the citizen cannot profit from yet. This may be because the results are not mature enough and have not left the laboratory, or because they have been successfully proved in other application domains, but not in the smart cities or civil use.

We can find the following application cases, among others:

- Social bots.
- Drones for civil uses.
- Big Social Data Management.
- Scada systems applied to the city management.

Design Centre Support

The Design Centre will provide the following support to the experimenter:

- Access to the infrastructures of the Spanish CPS Lab, with two well-supplied test beds in UPM's facilities in Madrid area with specialized hardware and software. More information on the Spanish CPS Lab here: http://www.cpse-labs.eu/spain.php
- Technical support, assistance and coaching to develop the experiment using IoT middleware SOFIA2, that provides seamless operability between devices and systems through a semantic interoperability platform to exchange information from the real world between smart applications (IoT) to build composed services with an open-source, multi-language, communication-agnostic approach. More information on SOFIA2 here: http://sofia2.com/home_en.html
- Access to the data generated by the sensor networks deployed in the IoT Smart Campus Montegancedo (to measure temperature, humidity, luminance, background noise and presence detection, for instance). Sensor network with mesh topology that communicate through a Std. IEEE802.15.4 Physical Layer under a 6LowPAN over IPv6 to implement Link and Network Layers. Technical support to communicate with the sensor networks of the IoT Smart Campus Montegancedo.
- Access to the sensor network data (including temperature, humidity, etc.) and use records of the Campus Sur Library Building (BUCS, http://www.upm.es/institucional/UPM/Bibliotecauniversitaria/bucs). BUCS has 3 stories, and one basement built on 10,345 m2, and that services more than 4000 students. BUCS building uses IQ204 and IQ251 to support the building management (e.g. temperature, humidity, or luminance). Technical support will be provided by CITSEM (https://www.citsem.upm.es/index.php/en/).

Expected Results

The experiment will provide a CPS development (software and/or hardware) that can be deployed in real-life conditions. The IPR management of the results must be defined with an exploitation plan. The experiment will also show the capabilities of the technologies provided by the Design Centre.

Expected Impact

The experiment must prove a clear contribution to the citizen environment that previously was not existent. The results must promote industrial development after the end of the experiment, with special focus on SMEs. The final products and exploitation policies must be clearly detailed, along with any barrier to access the developed technology. The business model that the experiment focuses at must be identified, defining the current value chain when applicable and how the adoption of CPS technology can improve it. An exploitation plan for the project results must be included, quantifying as far as possible the expected impact both in the experimenter's own business and it third parties' businesses.

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Call Topic – Third CPSE Labs Open Calls

Call Topic	Open platforms and patterns for Safe Autonomous Systems
Topic ID	16-SWE-01
CPSE Labs Design Centre	Sweden
Indicative Budget	€ 183,150 to be distributed between 1 - 3 experiments
Experiment's duration	9-12 months and ending before October 31st, 2017
Type of Experiment	Transfer to new domain Value chain completion

Overview

This call targets experiments to transfer or extend innovation and open approaches for realizing safe autonomous vehicles with primary focus on the automotive domain. Autonomous systems at high levels of automation, acting largely without human supervision, will incorporate very sophisticated algorithms including for perception and decision making. While the capabilities of such systems should help to bring about societal benefits, e.g. in terms of reducing car accidents, the systems themselves will be complex in that they will constitute non-linear hybrid systems that are likely to evolve through learning. The systems will consequently be very hard to verify and validate, and moreover difficult to deal with from a functional and system safety point of view. To enable the use of such algorithms there is a need to support their deployment by lowering thresholds in terms of investment and knowhow; this call addresses two related challenges as described in the following section.

Specific challenge

We expect proposals that are centred on one or both of the following two challenges. We will consider experiments carried out by one or more proposers when proposals are complementary, in order to achieve a broader coverage of both topics and collaboration among proposers.

Challenge 1: Open source platforms for prototyping autonomous, safety-critical systems to promote development of innovative solutions. By 'platforms' we refer to one or more modern technology 'stacks' characterized by all of the following:

a) comprise a suitable (sub-) set of hardware, real time operating system, board support packages, libraries, middleware, supporting tools (e.g. compilers), and frameworks (as basic services) for monitoring/interacting with code execution and logging /calibration of system variables;

b) provide a foundation on which other people and firms can develop complementary products, technologies or services (facilitated through e.g. licenses, the choice of technical approaches, documentation and supporting infrastructure);

c) are connected to an active community of people and firms that contribute to the platform.

In other words, we target the creation of such open modern technology stacks linked to clear strategies for growing into evolvable platforms. The chosen platform should support prototyping by non-experts in programming of embedded systems – primarily with regard to techniques for promoting novel safety-related services and robustness to software and hardware faults. The platform will require documentation of safety-related aspects and a fairly high level of supporting platform services. Examples of measures to promote robustness include the possibility to run the same code on different cores for detecting errors and separation of safety-relevant and non-safety-relevant code.

Challenge 2: Architectural patterns for facilitating the handling of safety and uncertainty by autonomous systems. We believe a key aspect of future autonomous, safety-critical systems will be their ability to act under uncertainty, and that application frameworks for supporting non-experts in uncertainty handling will be required. We are therefore seeking open-source contributions that encompass one or more of the following:

a) *Monitoring* application frameworks which assist in designing systems for reliable interventions when the state of a system and its environment is detected as hazardous, something which might occur due to system failures, a stochastic environment, unforeseen complex interactions between systems, etc. The application framework should include support for establishing and verifying relevant constraints, recovery strategies and "*safe states";*

b) *Evaluators* for establishing the trustworthiness of information, e.g. using belief propagation or Dempster-Shafer theory. This includes support for run-time decision making when several choices are more or less affected by uncertainty; and

c) *Tools and application frameworks* for facilitating off-line, safety-related learning through importing and exporting relevant data for off-line processing. This includes defining relevant data for (a) safety-related context(s), processing of data from a potentially large fleet of autonomous systems and support for updating run-time decision-making based on the results of analyses.

For both challenges, proposals need to provide a strategy for growing the results into a complete platform involving a living community, and arriving at means for supporting complementary products, technologies or services for prototyping. Proposals should thus explain how experiments will connect to and utilize already existing communities and platforms. It is further expected that even if the proposed solutions are not production-ready, that they should clearly support working with relevant safety standards: depending on what is delivered this might include templates for creating documentation, checklists for system integration, proof of code confirming to requirements by standards, etc. Furthermore, there should be no need for drastic changes to application software simply due to the need to move from prototyping to a production-ready platform.

Expected results

The following results are expected from completed experiments.

I. A public experiment description

II. A suitable demonstrator which illustrates the created benefits in an easily understandable way and which is available for later demonstrations at the Design Centre.

III. A platform (with components, such as hardware, associated with safety critical systems), and/or instantiated patterns for handling of safety and uncertainty.

   - Given a focus on challenge 1, an open platform should be provided that facilitates prototyping and working with relevant safety standards through appropriate documentation and software services. Contributions to the open platform could include tools, algorithms, software and hardware for realizing complex functionality for autonomous systems.

   - Given a focus on challenge 2, concrete instantiations of (one or more) relevant patterns should be provided, in one or more ways, as described by challenge 2. This could also include porting and demonstrating application frameworks, adapting software to relevant safety standards, support for formulating requirements/constraints and actions for transitioning into a fail-safe state, translating constraints and actions into executable safety rules and actions, tools, etc.

IV. Strategies and approach taken with respect to openness and relation to communities (e.g. for open source).

Design Centre Support

The design centre offers the following optional expertise and services, with no incurred costs to the experiment. Proposals should indicate the desired types and level of support required:

- Support on architectures, algorithms and safety engineering in relation to autonomous systems.
- Requirements and means for evaluating solutions referring to the Research Concept Vehicle (RCV) of the Integrated Transport Lab at KTH (https://www.itrl.kth.se/).
- Providing contacts with industrial domain experts (e.g. to elicit requirements and best practices) and open source communities,
- Support coaching of experiments with business analysis and hosting collaborative experiment meetings

The experiment will be conducted in collaboration with the French Design center that will act as advisors and additional competence providers for the experiment. Their Safety Monitoring Framework is one candidate technology for the realization of a monitoring application framework (https://www.laas.fr/projects/smof/).

Expected impact

Autonomous systems have many applications, and their expected spread in society implies that many will be safety related. Stimulating an open platform in this area thus both meets needs (potentially blocking innovation) while also creating business opportunities for creating and supporting such technologies.

The solutions developed in this experiment shall either:

- Use existing knowledge from one domain and bring it to another, with the primary focus on the automotive domain as a receiver (e. g. transferring knowledge about how to deal with autonomy in the avionics domain to the automotive domain); or
- Create new vendor-supplier relationships to create new products (e. g. capitalizing on open innovation to kick-start SME development of safety-critical systems).

The experiment is expected to contribute to the evolution of a platform community. Take up of the platform is seen to be relevant in several safety critical domains, including for both commercial and academic experiments in autonomous driving.

Call Topic – Third CPSE Labs Open Call

Call Topic	Multi-paradigm modelling for virtual commissioning in industrial automation
Call Topic ID	16-UK-GERS-01
CPSE Labs Design Centre	UK and Germany South
Indicative Budget	€ 155,000 to be distributed between 1 - 2 experiments
Experiment's duration	9-12 months and ending before October 31st, 2017
Type of Experiment	Transfer to new domain Value chain completion

Overview

Cyber-physical systems (CPSs) are challenging to design, particularly in industrial automation settings where systems are complex and control is distributed. Such systems may only be developed and deployed once or twice; commissioning is expensive and real-world testing may be infeasible due to the cost or destructive nature of tests. Model-based design is increasingly used to overcome these problems; however the engineers who develop cyber and physical elements often have their own techniques, formalisms and culture. A promising way to produce holistic models of CPSs is to create heterogeneous co-models ("collaborative models") that combine component models through co-simulation, allowing each component of the system to be modelled in the most appropriate tools.

In order to better address these points the UK and German Design Centres are combining platforms to permit the co-simulation of industrial automation systems, including Programmable Logic Controllers (PLCs), physical components and plant, computational and network elements. Specifically, the INTO-CPS (http://www.cpse-labs.eu/uk_intocps.php) platform permits co-simulation of continuous-time (CT) models of physical elements with discrete-event (DE) models of computing and network components, using the emerging Functional Mockup Interface (FMI, https://www.fmi-standard.org/) standard, which allows Functional Mockup Units (FMUs) generated from a variety of tools to be combined through co-simulation. The 4DIAC (http://www.cpse-labs.eu/gs_4diac.php) platform for PLC modelling will be extended to generate FMUs that can be used with the INTO-CPS platform.

Specific Challenge

We welcome experiment proposals from businesses who wish to apply the combined INTO-CPS and 4DIAC platforms and evaluate the combined platform's suitability as part of a development approach. The 4DIAC platform has been demonstrated in the manufacturing domain, but we are interested in how industrial automation can benefit from this combined platform. Domains for studies include, but are not limited to, building automation, traffic management, Smart Grids, robotics, or manufacturing.

In addition, experiments should:

- Build on and enhance the emerging 4DIAC/INTO-CPS platform, and substantially improve, validate or establish related development tools, technologies, or standards in automation scenarios of industrial relevance; including:
  - Virtual commissioning in industrial automation environments
  - Co-model development of industrial control solutions together with the simulation models
  - Model-based development of products and services

- Verification and validation for industrial automation systems
- Address one or more of the following goals:
  - Reduce development effort
  - Increase the maturity (technology readiness level) of industrial automation systems development approaches, tools, and platforms
  - Enable new products and services
- Show at least one of the following characteristics:
  - Involve new SMEs working with CPSE Labs and the UK and South German Design Centres
  - Develop new collaborations between businesses creating new value chains.

Design Centre Support

We offer the following expertise and services to experiments:

- *Training* on platforms or technologies:
  - INTO-CPS is an emerging tool chain for the design of cyber-physical systems (http://www.cpse-labs.eu/uk_intocps.php). Its core is co-simulation of heterogeneous co-models ("collaborative models") of FMUs based on the emerging FMI Standard. INTO-CPS supports FMUs from the following tools:
    - 20-sim Continuous-time (CT) models of physical systems and plant; in-built 3D visualisation.
    - Open Modelica Supports modelling of both low level and high level numerical algorithms.
    - Overture Discrete-event (DE) modelling using VDM (the Vienna Development Method).
    - Third-party FMUs INTO-CPS supports co-simulation of FMUs produced by other tools.
  - Around the co-simulation core, support is being developed for: a SysML profile and tool implementation for defining CPS as collections of cyber and physical subsystems that are used to automate co-simulation configuration; automated testing; hardware-in-the-loop (HiL) simulation and code generation; and design space exploration (DSE).
  - 4DIAC is an open-source solution for PLCs of the next generation (http://www.cpse-labs.eu/gs_4diac.php). It implements the IEC 61499 standard and therefore enables the development and management of platform-independent, distributed control applications as well as their real-time capable execution on any controller platform. 4DIAC allows to model the I/O interface of control applications in a generic, hardware-independent way. For simulation purposes this I/O interface can be connected to simulation tools when the control application is executed on simulated devices and to real I/Os when executed on control hardware without any special configuration effort.
- *Collaborative project* work to assist with focussed activities that may include:
  - Scoping of case studies and demonstrators.
  - Surveys and background research.
  - Assistance in technical work.

    - Communications support.
- *Hosting* of experiment meetings.

Proposals should indicate the desired types and level of support required.

Expected Results

The following results are required:

- Each experiment shall provide a demonstrator which illustrates the created benefit in an easily understandable way and is available for later demonstrations by the Design Centres.
- Achievements must be compared to the situation preceding the experiment, where possible on the basis of measured values from industrial applications.
- The results must be summarised in a publishable experiment description document.

Expected Impact

The results gained from the experiments shall be taken as starting point for the development of new products or services supplied to customers or directly transferred and applied for industrial use. The experiment shall therefore include a plan that describes how the project results will be further exploited beyond the experiment.