Cluster of EU FP7 Projects
ON SYSTEMS OF SYSTEMS

Issue n° 3

Newsletter • September 2015

Contents

Welcome from Prof Sebastian Engell, Project Coordinator of CPSoS

Dear Readers,

The Cluster of EU-FP7-projects on Systems of Systems is approaching the end of the second year of the projects. All four projects, AMADEOS (Architecture for Multi-criticality Agile Dependable Evolutionary Open System-of-Systems), DYMASOS (Dynamic Management of Physically Coupled Systems of Systems), Local4Global (Systems of Systems that act locally for optimizing globally) and the Coordination Action CPSoS (Towards a European Roadmap on Research and Innovation in Engineering and Management of Cyber-physical Systems of Systems) were reviewed at the end of May in Florence, Italy, and the reviewers were very positive about all four projects. The review meetings were held together with a public workshop on "Achievements in Systems of Systems Research and Innovation". A brief report from the workshop is given below and you can access the presentations via the link: "Open Workshop on May 28th, 2015". The work of the cluster is in full swing now and the projects are producing numerous important results, some are also described briefly in this newsletter.

The successful work of the cluster and the roadmapping activity of CPSoS have contributed to the fact that in the Draft Horizon 2020 Work Programme 2016-2017 in the area of Information and Communication Technologies of the European Commission, there is a planned call for the topic "Science of Systems Integration". It is described as: "The challenge is to design, programme and implement highly distributed and connected digital technologies that are embedded in a multitude of increasingly autonomous physical systems with various dynamics and satisfying multiple critical constraints including safety, security, power efficiency, high performance, size and cost. Such combination of several cyber-physical systems in "system of systems" gives rise to unpredictable behaviour and emergent properties. A significant improvement in design and programming of CPS is therefore needed including a "science of system integration". This is perfectly in line with the CPSoS Roadmap and with the disussions in the project cluster. So research and innovation in the domain of systems of systems, especially cyber-physical systems of systems, will continue to get support and will expand in the coming years.

Prof. Sebastian Engell,
Technische Universität Dortmund
Project Coordinator of CPSoS

These project have received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration.

News from the European Systems of Systems Research Cluster

Cluster Projects represented at the ARTEMIS Co-Summit 2015

Berlin, Germany - March 2015

Delegates from AMADEOS, CPSoS and DYMASOS attended the ARTEMIS Co-summit in Berlin, Germany on March 10th-11th, 2015. The objective of the participation at the event was to reach out to the ARTEMIS/ECSEL/ITEA communities and to increase our visibility in these communities.

The AMADEOS project was showcasing its advancements by a booth, where a poster, leaflets and slides show were available to be discussed with AMADEOS researchers.

CPSoS and DYMASOS had a joint booth. CPSoS promoted the public consultation on the initial roadmap document and initiated discussions on future research directions for cyber-physical systems of systems. DYMASOS used the occasion to present the initial results of the project with the help of flyers and two project posters and to participate in discussions on future research directions for the dynamic management of physically coupled systems of systems.

Workshop on Achievements in Systems of Systems Research and Innovation

Florence, Italy - May 2015

On May 28th, 2015 the European Research Cluster on Systems of Systems organized a Workshop on Achievements in Systems of Systems Research and Innovation in Florence, in conjunction with the project reviews. About 80 representatives from current (AMADEOS, CPSoS, DYMASOS, LOCAL4GLOBAL) and previous (CyPHERS, COMPASS, DANSE) EU-funded research projects were present at the workshop along with representatives from the European Commission and researchers interested in the domain.

During the workshop, the projects presented research results on **Systems of Systems Dynamics, Management and Control** and on **Models and Tools for Systems of Systems Engineering.** The presentations given at the workshop are available here.

During the last part of the workshop, the roadmap on Core Research and Innovation Areas in Cyber-physical Systems of Systems developed by CPSoS was presented to the audience and discussed. The importance of analysing and carefully designing the interactions between the computer systems that manage and control systems of systems and their human users was stressed. Cognitive cyber-physical systems of systems were outlined as a long-term goal of future research and development.

The workshop was also the occasion for sharing ideas on steps towards innovation in the domain with presentations of the running projects on their exploitation and innovation strategies. The potential for SoS innovation is enormous, mainly along two axes: more efficient operation of large systems as e.g. road traffic, railroads or energy and production systems under normal conditions, and avoidance of disruptions and increased resilience to disturbances and external influences. SoS solutions must be able to handle and efficiently manage changes in the composition and in the structures of the systems and in the drivers for management decisions and be able to handle legacy systems which are not fully modelled.

The results of systems of systems research are considered of key importance for the European society, as they will lead to cost-efficient, resilient and user friendly infrastructures and large-scale systems.

The rapporteur for the European Commission, Patrick Hartigan, summarised the outcome of the event as follows:

"A substantial improvement in efficiency of throughput and infrastructure can be anticipated across a range of industries. Reliability and resilience can be anticipated to improve, with consequent reduction in the threat of systems outages. SoS will greatly enhance the functionality of previously standalone devices and systems across a wide range of day-to-day applications, including transport, domotics and healthcare. Technology will become much easier to use and will start to show intelligence, taking into account factors such as human behavior, weather and environmental context. Results will be seen, for example, in improvements in carbon footprint and health outcomes. Continued support for research is required to maintain EU industrial leadership. SoS will happen. It is essential that the EU makes it happen and does not just watch it happening. Every citizen's life will be affected by SoS. Now is the chance to ensure that its development is guided by European priorities and values."

News from CPSoS

Public Workshop on Tools and Methods for Management and Engineering of CPSoS

Eindhoven, The Netherlands – February 2015

On February 9th, 2015 a Workshop on "Tools and Methods for Management and Engineering of CPSoS" took place at Eindhoven University of Technology (TU/e), Eindhoven, The Netherlands. The purpose of this workshop was to discuss research challenges in the area of Engineering of Cyber-Physical Systems of Systems as addressed by the FP7 Coordination and Support Action CPSoS.

Presentations were given by members of the CPSoS Working Group 3 on Tools and Methods for CPSoS and by several representatives of the local industry, both tool providers and tool users.

More information about the workshop, such as the entire program as well as some of the presentations, can be found here.

CPSoS Roadmap on Research and Innovation Priorities presented to the EC

The CPSoS consortium has prepared a Working Paper "Core Research and Innovation Areas in Cyber-physical Systems of Systems" that outlines the challenges and the key research and innovation areas in the domain of large systems that consist of physical structures and information processing elements, as e.g. railroad systems, electric grids and large industrial complexes.

The Working Paper was discussed by the CPSoS consortium and Working Group members with representatives of DG Connect of the European Commission on Dec. 3, 2014, in Brussels. The representatives of the Commission welcomed the proposals and fed them into the discussion process on the next Work Programme within the HORIZON 2020 Framework. The suggestions have been taken up in the Draft of the 2016-2017 ICT Work Programme.

Consult the presented Working Paper and the related presentations here.

Public Consultation of the CPSoS Roadmap

After the discussions in Brussels, the CPSoS Working Paper on "Core Research and Innovation Areas in Cyber-physical Systems of Systems", as well as the Analysis of the State-of-the-Art in Cyber-physical Systems of Systems have been made available for a public consultation from March 1st until June 30th, 2015, collecting additional comments, experiences, views and ideas. The public consultation is closed, but both documents, as well as the public comments received, can be consulted here.

The project consortium is now working on final recommendations, reflecting the needs of European society and industry. It will summarize its findings in a short brochure that targets a broader audience, and discuss with the interested community in a networking session "Systems of Systems Engineering: What Next?" at the conference ICT 2015 (Innovate, Connect, Transform), which is taking place on October 20th-22nd, 2015 in Lisbon, Portugal as well as in a workshop at the ARTEMIS Technology Conference on October 6th-7th in Torino, Italy

CPSoS – ARTEMIS-IA Cooperation

The ARTEMIS Industry Association is the association for actors in Embedded & Cyber-Physical Systems within Europe. As private partner, the association represents its members - industry, SMEs, universities and research institutes - in the ECSEL Joint Undertaking. It continuously updates the ARTEMIS Strategic Research Agenda (SRA) on Embedded & Cyber-Physical Systems, which reflects the Research & Innovation (R&I) needs of the industry. The ARTEMIS Industry Association is a membership organisation with more than 180 members and associates from all over Europe.

CPSoS has been invited to contribute to the strategic roadmapping activities of ARTEMIS-IA. The Coordinator of CPSoS, Prof. Sebastian Engell from TU Dortmund, presented the CPSoS Research and Innovation Roadmap at the ARTEMIS Summer Camp in Helsinki on June 10th and participated in the SRA Working Group meeting of ARTEMIS-IA in Brussels on August 20th-21st, 2015, also giving a presentation. Lively discussions followed his presentations, and there was general agreement that cyber-physical systems of systems are the next big challenge that has to be addressed in the development of management and design methods for hard- and software systems that tightly interact with the physical world, from embedded systems (small systems with computing elements) via cyber-physical systems (larger, networked systems) to the complex interconnected cyber-physical systems of systems.

AMADEOS Research Results

The AMADEOS Architectural Framework for evolvable SoS design

One of the main focus points for AMADEOS the past year has been the creation of the overall AMADEOS Architectural Framework (AAF). The AAF is intended to describe how an evolvable SoS architecture should be designed, the building blocks that are needed and the methodology that will be utilised. The AAF organizes the SoS design process into four phases: Mission, Conceptual Level, Logical Level and Implementation Level. Also, the AAF has adopted a viewpoint driven approach (See Figure 1): Within each of the phases, the seven AMADEOS viewpoints are addressed at different levels of abstraction, guiding the design process in increasing detail, and providing solutions to specific design problems while keeping the required interconnections among viewpoints. Key to the AAF is that it approaches SoS design as an ongoing process: In each of the 4 design phases, cycles take place that re-evaluate updated design inputs and produce updated design outputs. These design cycles increase in frequency as the design phases become more detailed and specific.

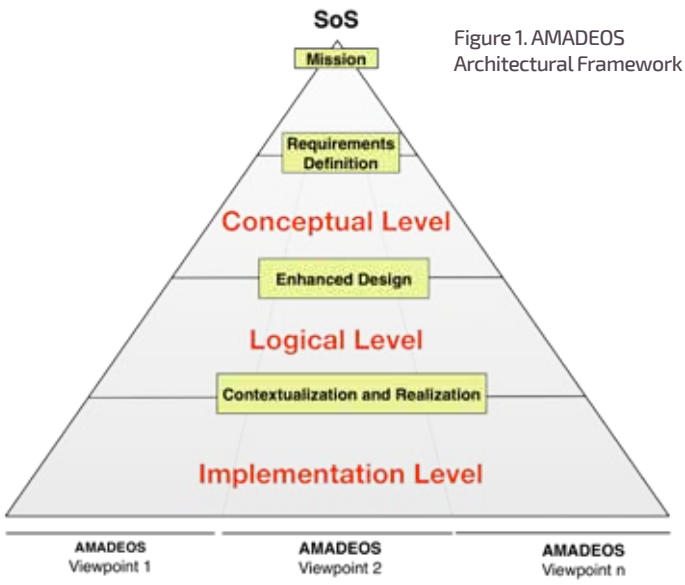

Figure 1. AMADEOS Architectural Framework

The AAF also provides a complete SysML model for architecting SoS. SysML (System Modeling Language) is a visual semi-formal modeling language defined to deal with the complexity of SoS development. SysML is defined as an extension of UML 2 by using the UML's profile mechanism therefore it represents an enabling technology for Model-Based Systems Engineering (MBSE). Profiles for custom stereotypes (i.e., blocks), tagged values, and constraints have been defined extending the reference metamodel UML 2 in order to support modeling and analysis of SoS. These profiles provide an abstract model to represent the topology and the state evolution of an operational SoS.

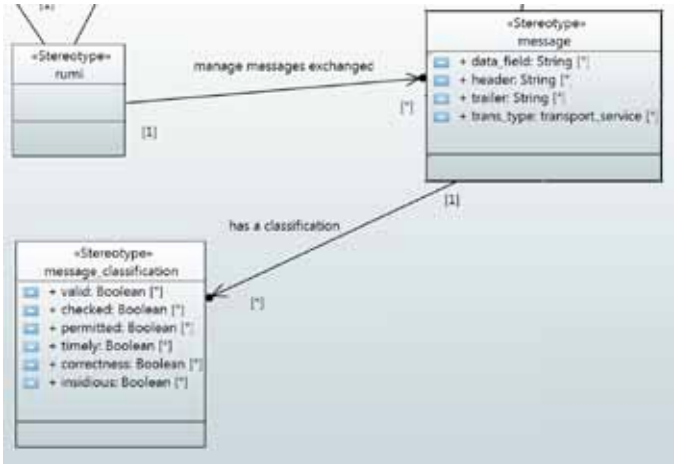

Figure 2. Example SysML Profile

In addition to the SysML model, the AAF also provides an SoS design toolkit, based on Blockly. Blockly is an open source library for building web-based visual programming editors. It uses Lego-like blocks which can be connected together to form the visual design. It also has the ability to perform checks during the design. The main advantages of Blockly are: I) no downloads or plugins are needed for designing and only a modern web browser is required, II) Provides an intuitive approach for the designer, III) it is easily extendable with custom blocks, IV) it supports code and XML generation, V) it supports checks during designing.

For each block in the AMADEOS SysML profile, its attributes and relationships are parsed and converted to Blockly (see Figures 2 and 3).

Figure 3. Blockly versions of Message and Message Classification

(Article continues on next page >)

The AMADEOS Architectural Framework for evolvable SoS design

The final element of the AAF is a set of building blocks that focus on core issues of AMADEOS like evolution, relied-upon interfaces, time-awareness or dependability, in order to extend the common practice in SoS design. The proposed SoS management infrastructure offers a set of patterns for monitoring, analysis, planning and execution of interactions between constituent systems (CS). Interactions among CSs are either based on relied-upon message interfaces (RUMI), which enable the direct exchange of information about past, present and future states of the SoS, or they are conducted via the relied-upon physical interface (RUPI), where information is transported indirectly by modification of properties of physical entities (e.g., flow of energy). This often happens without the intention to communicate. Since most SoS are inherently sensitive to the progression of time, AMADEOS advocates that every CS has access to a synchronized global source of time in order to facilitate SoS design. This requirement is supported by the development of a *Resilient Master Clock* that provides an IEEE 1588 compatible, fault tolerant source for internal clock synchronization.

The AMADEOS architectural framework will provide guidance towards designing and building SoS that are evolvable, dynamic, secure, and dependable, that can evolve and manage emergence and that can properly support time. These characteristics are presented as viewpoints into the SoS design. Developing an SoS using these viewpoints will allow SoS architects to concentrate on the important aspects of the SoS, simplifying their tasks when operating in extremely complex and critical environments. In the coming months, further work will be performed to fully expand these viewpoints by accurately instantiating and detailing the processes to be followed at each level.

News from DYMASOS

DYMASOS Invited Session at MATHMOD 2015

At the 8th MATHMOD conference, which took place on February 18th-20th, 2015 in Vienna, Austria, DYMASOS project partner RWTH organized a session on modelling of systems of systems. Partners ETH, TUDO and RWTH presented their results and discussed them with other researchers. The contributions to this session are available here: contributions to this session.

DYMASOS Presentations at the ECC 2015

DYMASOS partners presented four papers at the European Control Conference (ECC) 2015 which took place in Linz, Austria on July 15th–17th, 2015.

With their paper "A Mean Field Control approach for Demand Side Management of Large Populations of Thermostatically Controlled Loads", ETH Zurich presented a novel control approach for Demand Side Management (DSM) of large populations of flexible electric loads, such as electrical cooling/heating appliances (TCLs). The method proposes macroscopic incentives to steer the overall TCL population towards an equilibrium, and to avoid power demand peaks, typically due to duty-cycle synchronisation.

ETH Zurich further presented a paper "On Constrained Mean Field Control for Large Populations of Heterogeneous Agents: Decentralized Convergence to Nash Equilibria", proposing an approach to coordinate the optimal decisions of agents in a large population towards a Nash equilibrium. The methods are shown to converge asymptotically, if mild convex conditions on the problem data are fulfilled, extending previous literature results. The proposed algorithms are applied to the problem to coordinate the charging schedule of a large fleet of plug-in electric vehicles.

TU Dortmund and INEOS Köln presented "Real-Time Shared Resource Allocation by Price Coordination in an Integrated Petrochemical Site". The paper shows how market based algorithms can be applied to coordinate the operation of different units in a petrochemical production site, including a power plant, such that the networks of shared resources of the site are balanced and a site-wide economic optimum is reached.

University of Zagreb, Faculty of Electrical Engineering and Computing presented the paper "Analysis of Microgrid Power Flow Optimization with Consideration of Residual Storages State". In this paper, a power flow optimization of a DC microgrid that consists of a photovoltaic array, a batteries stack and a fuel cells stack with an electrolyser, and is connected to the grid via a bidirectional power converter.

DYMASOS consortium meeting in Malaga: Focus on electric mobility

Malaga, Spain – May 2015

On May 14th and 15th, 2015, the DYMASOS consortium assembled in Malaga, Spain for a plenary meeting. The meeting included a visit of the information and control center of the ZEM2ALL project on electrical mobility for the city of Malaga. The ZEM2ALL (Zero Emissions Mobility To All) project is a pioneer initiative that tries to give all citizens the opportunity of having at hand low-emissions mobility. About 200 electric cars and 23 quick charge points have been deployed in the city of Malaga.

The infrastructure and the vehicles are connected to this control center that manages the system and provides relevant information in real time to the users, as e.g. the location of the nearest fast loading station.

Researchers in DYMASOS are investigating how the charging stations can be operated and how the drivers and owners of the electric cars can be motivated to charge their vehicles such that the charging of electric vehicles is done when the energy demand is otherwise low but electric power generated from renewables is available, e.g. during the so-called "overnight demand valley".

DYMASOS Research Results

DYMASOS engineering tools integrate novel methods in industrial applications

The transfer of novel methods to real-world applications is the Achilles heel of many research projects. DYMASOS is also facing this challenge. Novel strategies as e.g. the price-based coordination of chemical production plants which was presented in the previous newsletter must be integrated into an industrial environment. This environment is very different from a research laboratory in terms of organisation, priorities and technologies. DYMASOS will address this issue by adopting concepts and tools for the engineering of SoS management methods.

Two main tasks are being tackled: Firstly, the management methods have to be validated in a simulation of the overall SoS which in turn consists of several smaller simulations of the individual systems. Secondly, the operating management algorithms have to access information on the operating SoS as e.g. its structure and operating states.

The general task of providing the required data to the management methods is simple. The main obstacle for the application of advanced management and control methods is not the integration as such but the effort of keeping these methods in operation during everyday business where there are continuous changes to the system under control. Thus, the main challenge is to keep the interdependencies between the SoS and the management strategies at a minimum level. If either the SoS or the management strategy changes, there should be no need to manually adjust the other part. A minimal, yet sufficient data interface is needed. Furthermore, this interface should rely on technologies that are suitable for an industrial environment.

From the perspective of an SoS management method, an SoS is a network of coupled systems in which processes are taking place. The management and control systems control the processes and take decisions on the operating modes. For example, a production plant creates a production plan and operates the production processes accordingly; a subscriber of an electric grid switches devices on and off to control processes that may consume or produce electrical energy. The first step in the development of the DYMASOS engineering tools has been to identify the basic terms for the description of a physically-coupled SoS, and to specify an according meta-model. The meta-model was then formulated in the CAEX (Computer Aided Engineering Exchange) language, a meta-model for system structure modelling with an XML representation which is targeted at data exchange between industrial engineering tools. CAEX is published as an IEC standard (IEC 62424).

An engineering tool for the creation and maintenance of corresponding CAEX-compliant SoS models is currently under development. Its main features are a browser-based user interface, the possibility of importing and exporting CAEX-compliant models, the integration of live data from the running SoS (e.g. measurement values) and limited archiving of data. For communication with the SoS, industrially applied communication protocols like ACPLT/KS and OPC UA will be supported.

The engineering tool supports the modelling and collection of all information that is required for the execution of SoS management methods. It will see its first application in the use case of management of a petrochemical site where it will be evaluated for the price-based site-wide coordination method.

Local4Global Research Results

Implementation of the Local4Global tools in buildings use cases:

1 Integration of the Local4Global strategy within a building simulator, which was constructed by ETH Zurich. The Local4Global tools were successfully used in the building simulator, and many experiments were conducted to tune important variables. Rule-based Controllers were used in order to compare the results. The Local4Global strategy demonstrated an improvement of 20%. Next steps include the use of more advanced algorithms like Model Predictive Algorithm and others, in order to compare the performance of the Local4Global strategy, and fine-tune the necessary parameters.

2 Implementation and use of the Local4Global strategy in larger scale systems. The aim is to use the Local4Global methods in bigger scale models in order to validate the Local4Global attributes. A 100 buildings use case has already been created (based on Energy-Plus) and experiments are being conducted in order to achieve better performance. Once again, compared to Rule-based Controllers, the Local4Global strategy offers already close to 10% improvement.

3 A novel scenario strategy is tested. This novel strategy, based on the creation of scenarios, will be integrated with the Local4Global strategy, in order to boost its speed and its requirements for less computational resources and time. Currently, different teams are working on that strategy, and a new building model based on EnergyPlus will be used for experimental purposes in order to validate their performance and their improvements.

Local4Global Traffic Use Case:

Recently the distributed control adaptive optimisation tool of Local4Global (namely: L4GCAO) has been developed and integrated within a VISSIM traffic simulation environment for testing and appropriate tailoring of the approach in practice. The simulation model emulates the dynamics and the behavior of the Federal Road B13 in the north of Munich (Germany) as shown in Figure 4.

Figure 4. Traffic Use Case site

The main goal of the approach is to adaptively fine tune the already existing, well-designed, and real-life adopted traffic light signaling control plans (*Base Case Scenarios*), through the built-in Hamilton-Jacobi-Bellman equation (*HJB*) based, self-learning mechanism in a periodic yet distributed/local manner as briefly shown in Figure 5. For more theoretical and functional details the interested reader is referred to Deliverable 4.1.1 of the Local4Global project.

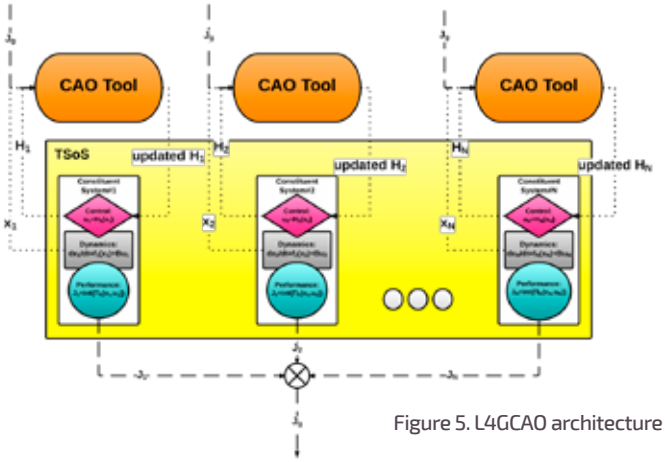

Figure 5. L4GCAO architecture

An independent Windows executable file was developed that is able to cooperate and communicate with the VISSIM external closed-loop optimization process. Even from the early stages of the preliminary co-simulation results it was more than evident that L4GCAO was able to outperform (by 9%) the Base Case Scenarios' performance scores (see Figure 6), even without any calibration of its parameters. Of course further calibration of the L4GCAO parameters is intended so as to increase the efficiency of the optimisation process in the next steps of the project.

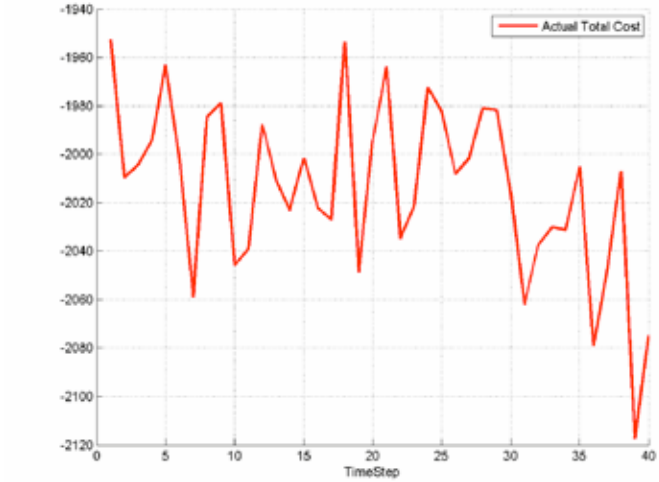

Figure 6. L4GCAO preliminary results from traffic co-simulation

Events organised by the Cluster Projects

Workshop at ARTEMIS Technology Conference

Turin, Italy – October 6, 2015

The ARTEMIS Industry Association will host the third meeting of the CPSoS Working Groups at the ARTEMIS Technology Conference 2015 in Turin, Italy. The meeting will take place on October 6th, starting 13h30 in the afternoon, and is open to all participants of the conference[1].

The ARTEMIS Technology Conference is a two-day event (October 6th-7th, 2015) that focuses on deep technological presentations, both on ARTEMIS project achievements and on state-of-the-art technology, in particular on cyber-physical systems and related challenges in different industrial areas.

The aim of the CPSoS meeting is to present and discuss six medium-term research priorities that have been identified in the project as being of high relevance over the next 5-7 years for both, general and domain-specific challenges. CPSoS will use the feedback obtained in this meeting to refine these challenges and to integrate them into the CPSoS Roadmap.

[1] CPSoS meeting attendants will need to register for the conference.

CPSoS Networking Session at ICT 2015

Lisbon, Portugal – October 22, 2015

CPSoS will hold a networking session "Systems of Systems Engineering: What Next?" during the conference ICT 2015 (*Innovate, Connect, Transform*), the largest ICT event organized by the European Commission, with thousands of attendants expected. In addition to networking events and opportunities, ICT 2015 will offer numerous events on new EC ICT policies and initiatives and funding opportunities, interactive exhibitions, and a start-up forum.

The objective of the CPSoS networking session, which will take place on October 22nd starting at 14h50, is to discuss the "What next?" in systems of systems engineering from the point of view of industrial and academic reality, based on the CPSoS Roadmap.

After short statements from the Project Coordinator and from two leading representatives of the European industries, an interactive discussion session will allow the attendants to provide feedback and new insights on the major research and innovation priorities of the next decade. The CPSoS project will use this feedback to refine the roadmap which will subsequently be disseminated to a wide audience, including decision makers from the Commission, from industry and from academia.

Presentations and Publications

Public Deliverables and Project Documents

The cluster projects have issued a number of public project documents that are available for consultation on their respective websites:

AMADEOS: Consult the documents here
DYMASOS: Consult the documents here
Local4Global: Consult the documents here
CPSoS: Consult the documents here

Publications of the Cluster Projects

AMADEOS

Invited presentation by **H. Kopetz**: **From Embedded Systems to System of Systems.** ITASC Workshop: Intelligent Transportation and Smart City, Tongij University, Shanghai, May 21-22, 2015

H. Kopetz, O. Höftberger, B. Frömel, F. Brancati, A. Bondavalli: Towards an Understanding of Emergence in Systems-of-Systems. Proc. of the 10th Annual System of Systems Engineering Conference (SoSE), San Antonio, TX, USA, May 17-20, 2015, pp 214-219

H. Kopetz, B. Frömel and O. Höftberger: Direct versus Stigmergic Information Flow in Systems-of-Systems. Proc. of the 10th Annual System of Systems Engineering Conference (SoSE), San Antonio, TX, USA, May 17-20, 2015, pp 36-41

A. Ceccarelli, M. Mori, P. Lollini and A. Bondavalli: Introducing Meta-Requirements for Describing System of Systems. Proc. of the 16th International Symposium on High Assurance System Engineering, HASE 2015, Daytona Beach, Florida, USA, January 8-10, 2015, pp 150-157

Visit the AMADEOS web site for the complete list of publications.

DYMASOS

Invited presentation by S. Engell: Management and Control of Cyber-physical Systems of Systems. Plenary presentation at ETAI 2015, Lake Ohrid, Mazedonia, September 24-26, 2015

G. Stojanovski, L.S. Maxeiner, S. Krämer, S. Engell: Real-Time Shared Resource Allocation by Price Coordination in an Integrated Petrochemical Site. Proc. of European Control Conference 2015, Linz, Austria, July 15-17, 2015, pp 1492-1497

M. Gulin, M. Vasak, M. Baotic: Analysis of Microgrid Power Flow Optimization with Consideration of Residual Storages State. Proc. of European Control Conference 2015, Linz, Austria, 15-17 July 2015, pp 3131-3136

F. Parise, S. Grammatico, M. Colombino, J. Lygeros: On constrained mean field control for large populations of heterogeneous agents: Decentralized convergence to Nash equilibria. Proc. of European Control Conference 2015, Linz, Austria, July 15-17, 2015, pp 3321-3326

S. Grammatico, B. Gentile, F. Parise, J. Lygeros: A Mean field control approach for demand side management of large populations of thermostatically controlled loads. Proc. of European Control Conference 2015, Linz, Austria, July 15-17, 2015, pp 3553-3558

T. Goldschmidt, M.K. Murugaiah, C. Sonntag, B. Schlich, S. Biallasz, P. Weber: Cloud-Based Control: A Multi-Tenant, Horizontally Scalable Soft-PLC. Proc. of IEEE International Conference on Cloud Computing (CLOUD), New York, USA, June 27- July 2, 2015, pp 909-916

T. Goldschmidt, M.K. Murugaiah, B. Schlich, P. Weber, C. Sonntag, S. Biallasz: Cloud-basierte Steuerungen: Eine horizontal skalierbare, multi-tenant-fähige Soft-SPS. AUTOMATION 2015, Baden-Baden, Germany, 11-12 June 2015.

Invited presentation by S. Engell: Research Challenges in Cyber-physical Systems of Systems. Dutch Institute of Systems and Control Summer School on Control for CPS, Zandvoort, June 4, 2015.

S. Nazari, C. Sonntag and S. Engell: A Modelling, Simulation, and Validation Framework for Large-scale Processing Systems with Distributed Management. Proc. of PSE/ESCAPE 2015, Copenhagen, Denmark (Computer Aided Chemical Engineering, Vol.37, 2015), May 31 –June 4, 2015, pp 269-274

D. Kampert, U. Epple, S. Nazari, C. Sonntag, S. Engell: A Framework for Simulation, Optimization and Information. Proc. of the 15th IFAC Symposium on Information Control Problems in Manufacturing (INCOM 2015), Ottawa, Canada, May 11-13, 2015, pp 1598-1603

D. Kampert, U. Epple: Challenges in the Modelling and Operation of Physically Coupled Systems of Systems. Proc. of MATHMOD 2015, Vienna, Austria, February 18 – 20, 2015, pp 916-917

B. Gentile, S. Grammatico, J. Lygeros: Mean field modeling of large-scale energy systems. Proc. of MATHMOD 2015, Vienna, Austria, February 18 – 20, 2015, pp 918-919

(Article continues on next page >)

S. Nazari, C. Sonntag, S. Engell: A Modelica-based Modeling and Simulation Framework for Large-scale Cyber-physical Systems of Systems. Proc. of MATHMOD 2015, Vienna, Austria, February 18 – 20, 2015, pp 920-921

S. Engell, J. Lygeros, S. Grammatico: The emergence of systems of systems. Pan European Networks: Science & Technology, Vol 14, pp 79-81, 2015

F. Parise, M. Colombino, S. Grammatico and J. Lygeros: Mean field constrained charging control policy for large populations of plug-in electric vehicles. Proc. of the IEEE Conference on Decision and Control, Los Angeles, CA, USA, December 15-17, 2014, pp 5101 - 5106

Visit the DYMASOS web site for the complete list of publications.

Local4Global

S. Baldi, I. Michailidis, C. Ravanis, E.B. Kosmatopoulos: Model-based and model-free "plug-and-play" building energy efficient control. Applied Energy, 154, pp 829-841, 2015

S. Baldi, A. Karagevrekis, I.T. Michailidis, E.B. Kosmatopoulos: Joint energy demand and thermal comfort optimization in photovoltaic-equipped interconnected microgrids. Energy Conversion and Management, 101, pp 352-363, 2015

I.T. Michailidis, S. Baldi, E.B. Kosmatopoulos, M.F. Pichler, J.R. Santiago: Improving energy savings and thermal comfort in large-scale buildings via adaptive optimization. Control theory: perspectives, applications and developments, Nova Science Publishers, 2015

T. Schild, J. Fütterer, R. Sangi, R. Streblow, D. Müller: System of Systems theory as a new perspective on building control. In Control and Automation (MED), 2015, 23rd Mediterranean Conference on Control and Automation, Torremolinos, Spain, June 16–19, 2015, pp 783-788

D. Manolis, C. Diakaki, I. Papamichail, M. Papageorgiou: Comparative evaluation of two alternative approaches for the decentralized real-time signal control of urban networks. Proc. of 4th International Symposium & 26th National Conference on Operational Research, Chania, Greece, June 4-6, 2015, pp 196-200

Visit the Local4Global web site for the complete list of publications

CPSoS

M.A. Reniers, S Engell and H. Thompson: Core Research and Innovation Areas in Cyber-Physical Systems of Systems. ERCIM News 2015 (102). pp 11-13, 2015

Visit the CPSoS web site for the complete list of publications.

Other Systems of Systems Related Events

ARTEMIS Technology Conference 2015

October 6 – 7, 2015 – Turin, Italy

This year's ARTEMIS Technology Conference will provide a deep technological insight on specific Cyber-Physical System themes, both from project achievements and on state-of-the-art technology.

The concept of this Technology Conference is based on various parallel technical sessions, each built around five themes based on future challenges for CPS.

The 16th IFAC Workshop on Control Applications of Optimization (CAO'2015)

October 6 – 9, 2015 – Garmisch-Partenkirchen, Germany

CAO'2015 is the 16th IFAC workshop on control applications of optimization. Its goal is to provide an overview of the latest advances in the theory of optimal control, especially those in which new methods and numerical algorithms are applied in order to solve problems in industry, economics, finance and ecology.

It will give specialists in the fields of optimal control, differential games, and optimization an opportunity to share their experiences with practitioners, to discuss new research directions and new problems that are arising, and to outline scientific and commercial applications.

One aim of the workshop is to bring together researchers and engineers, applied economists and environmental scientists, providing an up-to-date survey of the major applications of optimization for control purposes and for decision-making in economics and in the industry.

ICT 2015 - Innovate, Connect, Transform

October 20 – 22, 2015 – Lisbon, Portugal

ICT 2015 is the biggest ICT event in the EU, organised by the European Commission, together with the Fundação para a Ciência e a Tecnologia.

The ICT 2015 event will comprise a number of parallel activities:

- A policy conference presenting the new Commission's policies and initiatives on Research & Innovation in ICT (Horizon 2020 Programme);
- An interactive exhibition showcasing the best results and impact of most recent EU ICT Research & Innovation;
- Many networking opportunities to enhance quality partnerships, help participants find partners, connect Research and Innovation and trigger collaboration;
- Funding opportunities: ICT 2015 will also be the place to gather information on the 2016-17 Work Programme of Horizon 2020.

9th IFAC Symposium on Control of Power and Energy Systems (CPES) 2015 (CPES 2015)

December 9 – 11, 2015 – New Delhi, India

The symposium continues the tradition of the IFAC Symposium on Power Plants and Power Systems Control and will showcase novel research results and application in the control of electric power and energy systems. Particular emphasis will be given to smart grid technologies; design, simulation and real time operation of control and operation of renewable energy systems; microgrids; distributed networks; virtual inertia and elimination of harmonics in inverter based systems. Contributions in the area of energy development and planning; deregulated power markets; control and development of conventional power systems; operation, optimization, planning, analysis and expansion of large power systems; instrumentation and control systems; HVDC transmission systems and FACTS; future challenges to electrical networks and their solutions; and use of plug-in hybrid electric vehicles / intelligent autonomous vehicles are also welcome.

IEEE 54th Annual Conference on Decision and Control (CDC)

December 15 – 18, 2015 - Osaka, Japan

The CDC is recognized as the premier scientific and engineering conference dedicated to the advancement of the theory and practice of systems and control. The CDC annually brings together an international community of researchers and practitioners in the field of automatic control to discuss new research results, perspectives on future developments, and innovative applications relevant to decision making, automatic control, and related areas.

7th IFAC Conference on Management and Control of Production and Logistics (MCPL 2016)

February 22 – 24, 2016 - Bremen, Germany

The conference aims to bring together researchers and practitioners from different areas of Management and Control of Production and Logistic Systems. The objective is to promote a synergy among different disciplines in order to explore new solutions for complex scientific and technical challenges. The scope relates to production and logistic systems.

The IFAC MCPL 2016 will be held in conjunction with the 5th International Conference on Dynamics in Logistics LDIC 2016. The conferences will be accompanied by several satellite events.

CPS Week 2016

April 11 – 14, 2016 – Vienna, Austria

CPS Week is the premier event on Cyber-Physical Systems. It brings together four top conferences, HSCC, ICCPS, IPSN, and RTAS, 10-15 workshops, a localization competition, tutorials and various exhibitions from both industry and academia. Altogether the CPS Week program covers a multitude of complementary aspects of CPS, and reunites the leading researchers in this dynamic field.

International Conference on Integrated Formal Methods (iFM2016)

June 1 – 4, 2016 – Reykjavík, Iceland

Applying formal methods may involve the usage of different formalisms and different analysis techniques to validate a system, either because individual components are most amenable to one formalism or technique, because one is interested in different properties of the system, or simply to cope with the sheer complexity of the system. The iFM conference series seeks to further research into hybrid approaches to formal modelling and analysis; i.e., the combination of (formal and semi-formal) methods for system development, regarding both modelling and analysis. The conference covers all aspects from language design through verification and analysis techniques to tools and their integration into software engineering practice.

11th International Symposium on Dynamics and Control of Process and Bioprocess Systems (DYCOPS - CAB 2016)

June 6 – 8, 2016 – Trondheim, Norway

The 11th IFAC Symposium on Dynamics and Control of Process Systems, including Biosystems (DYCOPS-CAB 2016) is organized by the Norwegian University of Science and Technology, departments of Chemical Engineering and Engineering Cybernetics, together with the Norwegian Society of Automatic Control, the IFAC NMO of Norway. DYCOPS-CAB 2016 is sponsored by the IFAC Technical Committee on Chemical Process Control (6.1) and co-sponsored by the IFAC Technical Committee on Biosystems and Bioprocesses (8.4).

The DYCOPS symposium has now been merged together with CAB (Computer Applications in Biotechnologies) into a single three-day conference. Thus, in the new format, sessions that were traditionally held under the DYCOPS and CAB umbrella will be held in parallel.

ESCAPE 26

June 12 – 15, 2016 – Portorož, Slovenia

ESCAPE (European Symposium on Computer Aided Process Engineering) addresses academia and industry coming from all of the world, to present their latest, state of the art research results in the field of Computer Aided Process Engineering / Process Systems Engineering.

International Conference on System of Systems Engineering 2016 (SoSE 2016)

June 12 – 16, 2016 - Kongsberg, Norway

The 11th International Conference on System of Systems Engineering (SoSE) has vast ramifications in numerous engineering fields such as control, computing, communication, information technology and in applications such manufacturing, defense, national security, aerospace, maritime, energy, environment, healthcare, and transportation. The conference theme is “SoSE and Cyber Physical Systems (CPS), from academia to application and back”.

8th IFAC Symposium on Advances in Automotive Control (AAC 2016)

June 20 – 23, 2016 - Kolmården Wildlife Resort, Sweden

The goal of IFAC-AAC symposium is to contribute to the future research and development by active exchange of knowledge and vision between engineers from industries and academia. In addition to the main symposium there will be a pre-symposium tutorial covering both basics and emerging areas within Automotive Control and it will be organized at Linköping University Campus, Saturday, June 18 – Sunday, June 19.

8th IFAC Conference on Manufacturing Modelling, Management & Control (MIM 2016)

June 28 – 30, 2016 – Troyes, France

The general theme of MIM 2016 is Optimization and Systems Science for Risk Management and Disruption Recovery Control. The conference will focus in particular on the most innovative methods proposed in the last few years in the context risk management, resilience, and disaster recovery control in the 21st century.

European Control Conference 2016 (ECC16)

June 29 – July 1, 2016 – Aalborg, Denmark

The European Control Conference, which is organized annually under the auspices of the European Control Association (EUCA), brings together academic and industrial professionals in the field of systems and control and promotes scientific cooperation and exchanges within the European Union and between Europe and other parts of the world.

The 2016 American Control Conference (ACC 2016)

July 6 – 8, 2016 – Boston, MA, USA

The ACC is the annual conference of the American Automatic Control Council (AACC), the U.S. national member organization of the International Federation for Automatic Control (IFAC).
It is internationally recognized as a premier scientific and engineering conference dedicated to the advancement of control theory and practice. The ACC brings together an international community of researchers and practitioners to discuss the latest findings in automatic control. The 2016 ACC technical program will comprise several types of presentations in regular and invited sessions, tutorial sessions, and special sessions along with workshops and exhibits. Submissions are encouraged in all areas of the theory and practice of automatic control.

The 26th Annual INCOSE International Symposium

July 18 – 21, 2016 – Edinburgh, United Kingdom

The Annual INCOSE International Symposium is the premier international forum for Systems Engineering. Participants network, share ideas, knowledge and practices, and learn more about the most recent innovations, trends, experiences and issues in Systems Engineering. The symposium in 2016 will focus on the theme "Achieving excellence through Systems Engineering"

PLEASE PROVIDE YOUR FEEDBACK!

Do you have information to share?
An SoS related event to promote?
Questions? Suggestions?

Contact: d.marron@inno-group.com

or the project coordinators:

AMADEOS – Andrea Bondavalli
DYMASOS – Sebastian Engell
Local4Global – Elias Kosmatopoulos
CPSoS – Sebastian Engell