Towards a European Roadmap on Research and Innovation in Engineering and Management of Cyber-Physical Systems of Systems

Project Deliverable

Project Number:	Project Acronym:	Project Title:
611115	CPSoS	Towards a European Roadmap on Research and Innovation in Engineering and Management of Cyber-Physical Systems of Systems

Instrument:	Thematic Priority
COORDINATION AND SUPPORT ACTION	ICT

Title

D3.1 Report on the third meeting of the Working Groups (joint meeting)

Due Date:	Actual Submission Date:
Month 26 (November 2015) *–> after first amendment*	Month 27 (December 7th, 2015)

Start date of project:	Duration:
October 1st, 2013	33 months *–> after first amendment*

Organization name of lead contractor for this deliverable:	Document version:
inno	V2.0

Dissemination level (Project co-funded by the European Commission within the Seventh Framework Programme)

PU	Public	**X**
PP	Restricted to other programme participants (including the Commission)	
RE	Restricted to a group defined by the consortium (including the Commission)	
CO	Confidential, only for members of the consortium (including the Commission)	

Abstract :

This document is the summary about the third (joint) meeting of Working Group, which was organised as an Open Workshop at the occasion of the ARTEMIS Technology Conference on October 6th 2015 in Turin, Italy.

Authors (organizations):

Dagmar Marron, Svetlana Klessova (inno)

Radoslav Paulen (TUDO)

Reviewers (organizations):

Sebastian Engell (TUDO)

Keywords :

Working Groups, SoS, Cyber-physical systems of systems, Medium-Term Research Priorities

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

Revision History

The following table describes the main changes done in the document since it was created.

Revision	Date	Description	Author (Organisation)
V1.0	6/11/2015	Creation	Dagmar Marron (inno)
V1.1	19/11/2015	Initial review and contribution	Svetlana Klessova (inno)
V1.2	23/11/2015	Revision and contribution	Radoslav Paulen (TUDO)
V1.3	06/12/2015	Revision	Sebastian Engell (TUDO)
V2.0	07/12/2015	Finalisation	Dagmar Marron (inno)

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

Table of Contents

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

Acronyms and Definitions

Acronym	Defined as
CPS	Cyber-physical Systems
EC	European Commission
FP7	7th Framework Programme for Research and Technological Development
IoT	Internet of Things
IP	Integrating Project
R&D	Research and Development
SoS	Systems of systems
STREP	Specific Targeted Research Project
ToR	Terms of Reference
WG	Working Group

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

1. Executive Summary

CPSoS, funded by the EC (FP7 programme), is a 30-months Support Action that provides a forum and an exchange platform for systems of systems related communities and ongoing projects, focusing on the challenges posed by the engineering and the operation of technical systems in which computing and communication systems interact with large complex physical systems. Its approach is simultaneously integrative, aiming at bringing together knowledge from different communities, and applications-driven.

The project findings will, at the end of the project, be summarised in a concise strategic policy document, supported by a set of in-depth technical papers, presented at a symposium "Cyber-physical Systems of Systems Meeting Societal Challenges".

The CPSoS project has, during the last months, prepared a Working Paper on 'Core Research and Innovation Areas in Cyber-physical Systems of Systems', outlining the challenges and key research and innovation areas in the domain of large systems that consist of physical structures and information processing elements. This Working Paper, as well as the related paper on conducted 'Analysis of the State-of-the-Art and Future Challenges in Cyber-physical Systems of Systems' have provided the basis for the current work on a document 'Cyber-physical Systems of Systems Research Agenda 2015-2025'.

The third meeting of the CPSoS Working Groups (WGs) was organised jointly for the three Working Groups as an Open Workshop on Medium-Term Research Priorities for Cyber-Physical Systems of Systems as part of the ARTEMIS Technology Conference 2015 in Turin, Italy. The CPSoS Workshop took place on October 6th, 2015 and consisted of an Opening session, introducing the project and presenting the CPSoS Research and Innovation Domains, followed by contributions from members of the CPSoS Working Groups and finally a third session, where the project consortium presented the following research and development topics, comprising several sub-topics as the main challenges for the next 5-7 years, which have been defined within the before mentioned research agenda:

Overarching topics:

- Overcoming the modelling bottleneck
- System integration and dynamic reconfiguration
- Robust distributed control and optimization
- Resilience in systems of systems
- Humans in the loop
- Towards cognitive systems

Furthermore, domain-specific topics have been proposed for the areas of:

- Industrial production systems
- Manufacturing systems
- Transportation and logistics

The focus of the Workshop was on the presentations and discussions of the medium-term research priorities in the area of cyber-physical systems of systems.

More than 25 participants, CPSoS Working Group members and external specialists, engaged in lively and fruitful discussions. The feedback and suggestions of the participants will be integrated into the CPSoS strategic research agenda.

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

2. Opening Session

The Workshop started with a presentation, given by the Project Coordinator – Prof Sebastian Engell – introducing to the scope of the CPSoS project, its concept and its goals, and providing an overview of the progress made and the achievements reached by the project so far.

Based on this general introduction, the CPSoS Working Group Chairs provided a report on the outcomes of the earlier Working Group meetings and different consultations of experts in the domain.

The Chairs of the three CPSoS Working Groups – Haydn Thompson (WG1), Sebastian Engell (WG2) and Michel Reniers (WG3) – presented the three core research and innovation areas that have been identified by the CPSoS project as outcome of numerous discussions with WG members and interviews with domain practitioners.

During the discussions that followed, participants of the workshop asked for a more detailed qualification on one of the presented challenges, i.e. the changing scope of the system and it was explained that this aspect arises from the evolving nature of a system.

The participants further pointed out that more precision about the terms and concepts in cognitive systems were needed, e.g. that the differences between the terms “situation-awareness” and “understanding of the data” should be clarified. This was agreed to by the CPSoS consortium.

During a discussion on the topic “Humans in the loop” it was stressed that the users of CPSoS have to be “in charge” and should not be put out of real-time operation by design. On the other hand, humans should be instructed accordingly to be aware of the consequences of their actions. Informed consent was mentioned as a model on how to keep operators “in the loop” when optimal decisions are computed by an automated system.

Interactions with unknown systems were mentioned as a further important challenge.

The question of safety in CPSoS was thoroughly discussed, showing joint industrial and academic interest. For example, a need for research on “fail-safe mechanisms” resulted from the discussion which CPSoS will include into the recommended research priorities.

The increased deployment of, especially wireless, sensing technology was pointed out as an important driver of the technological innovation. The need for energy-harvesting technologies was mentioned.

This project has received funding from the European Union’s Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

3. Contributions from Members of the CPSoS Working Groups and Discussion

Francesco Brancati (ResilTech SRL), a delegate from AMADEOS (an EU FP7-project within an SoS project cluster) and member of the CPSoS WG 2 (Physically connected Systems of Systems), gave a presentation on time awareness, modelling of stigmergic channels and emergent behaviour in cyber-physical systems of systems. The following discussion was conducted around the question of quantification of complexity of a system and recent technologies for time synchronization in CPSoS.

Erwin Schoitsch (AIT - Austrian Institute of Technology), member of the CPSoS project WG 3 (Tools for system engineering and management), discussed the issues of security and safety in CPSoS. He used examples from autonomous driving and touched upon the topics of data privacy and standardisation.

Alessandro Cimatti (Bruno Kessler Foundation), a member of WG3, then presented the topics of contract-based design, model checking, and model-based safety analysis. The subsequent discussion evolved around the scalability and applicability of contract-based design and assume-guarantee reasoning in design of CPSoS. Mr. Cimatti pointed out that success stories of the methodology for real-world use cases exist.

Alberto Bemporad (IMT Institute for Advanced Studies Lucca), another member of WG3, communicated his vision on the real-time optimisation and optimisation-based control of CPSoS. He presented several results of the application of fast model predictive control on the use cases in the framework of European projects e-price (oriented to smart grid operation), effinet (conducting a research in the domain of drinking water networks) and DISIRE (with the focus on chemical production). In this context it was pointed out that, in many cases, computing time does not present a bottleneck but that the issues are more on the side of engineering effort needed for the solution.

Alf Isaksson (ABB), member of WG2, presented the vision of ABB on the future of industrial control and automation. He discussed the next generation automation pyramid, availability of sensors, industrial demand-response, internet of people, services and things, optimization-based operator support via cloud services, data availability and sharing and stressed that the business models are one of the key aspects of the development and innovation. Regarding autonomous operation, he envisioned people to be in the role of monitoring agents with the ability to interact with the system in abnormal situations.

Patrick Panciatici (RTE - Réseau de Transport d'Electricité), another member of WG2, discussed the future role of ICT in power systems. He stressed that the role of ICT already changed from being a technology allowing system optimisation into being an enabler of stable operation of power grids in Europe. In his presentation he mentioned that the key CPSoS challenges and opportunities in power grids are Co-design of hardware and software, Control of inverter-based generation units, Control of large populations of devices and agents, Big data, IoT technology and High Performance Computing.

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

4. Presentation of the CPSoS Medium-Term Research Priorities

Six overarching topics for medium-term research and innovation activities were presented. These included: Overcoming the modelling bottleneck, System integration and dynamic reconfiguration, Robust distributed system-wide control and optimisation, Resilience in systems of systems, Humans in the loop, and Towards cognitive systems: data-based system operation. These topics are suggestions for further call topics in the HORIZON 2020 framework or in national research initiatives.

The domain-specific topics included: Integration of control, scheduling, planning and demand-side management (in the domain of process industries), Development and exploitation of ICT to support multi-disciplinary, multi-objective optimization of operations in complex, dynamic, 24/7 systems (in the automotive and logistics domains), Safe, secure and trusted autonomous operations for systems with humans in the loop (in the automotive domain), New ICT infrastructures for adaptable, resilient, and reconfigurable manufacturing processes, Data and information visualisation for decision support in manufacturing.

A short overview about discussions and input provided by the participants on these presentations is given hereafter:

Overcoming the modelling bottleneck

Modelling was confirmed to be a backbone of the majority of future developments in CPSoS engineering. The topic of model validation was discussed extensively, mentioning model validation for different purposes (such as optimisation, control, or safety), complexity of model implementation (simulation) and verification/certification. P. Panciatici suggested to simplify the term “automated model building” to “system identification”. Reconfiguration of the models was mentioned as an additional research challenge for overcoming the modelling bottleneck.

Robust distributed system-wide control and optimisation

A clarification of the term “system-wide control” was asked for. A. Isaksson stressed that system-wide control is needed in certain areas, such as power grids. Control of legacy systems was suggested as an additional sub-topic in the discussed framework.

Resilience in SoS

The discussed topics included safety, security and dependability. The issues of standardisation were briefly mentioned. It was proposed to alter the heading “Interaction of monitoring systems” as “Collaboration of monitoring systems”. The idea of fail-safe systems was suggested to be missing in the presented topic.

Humans in the loop

The trend of deterioration of human abilities to react to unforeseen situations was mentioned. One conclusion was that the modelling of human behaviour is an open research topic and suggested to approach this problem as a combination of qualitative and quantitative modelling. It was further pointed out that a knowledge basis for modelling of human reactions exists. Training and selection of operators was mentioned as a good practice for reduction of variability in human reactions.

Towards cognitive systems: data-based system operation

The participants raised concerns regarding the system stability when data-based system operation is conducted. They suggested to include data-based co-engineering among the presented topics.

In the area of research and innovation domains in the process industries, another suggestion was to include preventive maintenance of the system assets based on refined monitoring of their state into the medium-term research and innovation domains.

This project has received funding from the European Union’s Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

5. Conclusion and next steps

The discussions confirmed the analysis of the CPSoS project of the state of the art and the research priorities in the domain of cyber-physical systems of systems. The medium term priorities were supported and valuable additions and refinements were proposed. The feedback will be integrated into the final formulation and presentation of the research agenda.

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

6. Annexes

6.1. Agenda

Workshop on Medium-Term Research Priorities for Cyber-physical Systems of Systems

Tuesday, October 6th, 2015 – Turin/Italy

Venue: Starhotels Majestic

Room: Eleonora – *Address*: Corso Vittorio Emanuele II, 54, 10123 Turin – Italy

Agenda

12h30-13h30	*Arrival of participants, lunch (provided by ARTEMIS) & networking*
	Opening
13h30-13h45	**Introduction and Overview of CPSoS**
13h45-14h15	**CPSoS Research and Innovation Domains** Presentations by CPSoS and Discussion
	Contributions from Members of the CPSoS Working Groups and Discussion
14h15-16h00	**Contributors** • Francesco Brancati / ResilTech SRL, Italy • Erwin Schoitsch / AIT - Austrian Institute of Technology, Austria • Alessandro Cimatti / Bruno Kessler Foundation, Italy • Alberto Bemporad / IMT Institute for Advanced Studies Lucca, Italy • Alf Isaksson / ABB, Sweden • Patrick Panciatici / RTE, France
16h00-16h15	*Coffee break*
16h00-16h15	**Presentation of the CPSoS Medium-term Research Priorities**
	Overarching topics: • Overcoming the modelling bottleneck • System integration and dynamic reconfiguration • Robust distributed system-wide control and optimization • Resilience of systems of systems • Humans in the loop • Towards cognitive CPSoS – data-based system operation

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

1

	Sector-specific topics
	• Process industries:
	  ○ Integration of control, scheduling, planning and demand-side management
	• Transportation and logistics:
	  ○ Development and exploitation of ICT to support multi-disciplinary, multi-objective optimization of operations in complex, dynamic, 24/7 systems
	  ○ Safe, secure and trusted autonomous operations for systems with humans in the loop
	• Manufacturing:
	  ○ New ICT infrastructures for adaptable, resilient, and reconfigurable manufacturing processes
	  ○ Data and information visualization for decision support in manufacturing

17h00-18h00	**Discussion and prioritization**
18h00	**End of the workshop**

6.2. List of Participants

Members of the CPSoS consortium:

Engell	Sebastian	TU Dortmund, Germany
Thompson	Haydn	Haydn Consulting, United Kingdom
Reniers	Michel	TU Eindhoven, Netherlands
Paulen	Radoslav	TU Dortmund, Germany
Sonntag	Christian	euTEXoo, TU Dortmund, Germany

Working Group members:

Bemporad	Alberto	IMT Institute for Advanced Studies Lucca, Italy
Brancati	Francesco	ResilTech SRL, Italy
Cimatti	Alessandro	Bruno Kessler Foundation, Italy
Isaksson	Alf	ABB, Sweden
Liatard	Philippe	CEA – LETI, France
Panciatici	Patrick	RTE - Réseau de Transport d'Electricité, France
Schoitsch	Erwin	AIT - Austrian Institute of Technology, Austria

Other participants of the workshop:

Cancila	Daniela	CEA LIST, France
Chen	DeJiu	KTH, Sweden
Eckel	Andreas	TTTech, Austria
Esen	Hasan	DENSO Automotive Deutschland GmbH, Germany
Lienert	Dieter	Bosch, Germany
Martinsson	Par-Erik	Process IT.EU / LTU, Finland
Palumbo	Francesca	University of Sassari, Italy
Paulweber	Michael	AVL, Austria
Polcaro	Carmen	Asociacion Innovalia, Spain
Pomante	Luigi	Universita degli Studi dell'Aquila - Center of Excellence DEWS, Italy
Pronios	Nikos	Innovate UK, UK
Sinclair	Murray	Loughborough University, UK
Viinikka	Eeva	Spinverse, Finland

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

6.3. Photo from the Workshop

6.4. Presentations

All the presentations given at the occasion of the workshop have been made available for consultation in the News/Events section of the CPSoS website. (http://www.cpsos.eu/news-events/workshop-on-cyber-physical-systems-of-systems-roadmap-on-oct-6-2015-at-artemis-technology-conference/).

As an example, the presentation on “Medium-Term Research and Innovation Domains in Cyber-physical Systems of Systems”, given by the CPSoS project partners and providing the basis for the following discussions, is made available hereafter.

This project has received funding from the European Union’s Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

Overcoming the modelling bottleneck

- Faster model development and better model reuse, automated modelling
- Model maintenance and adaptation
- Collaborative environments for model exchange between competing companies, trust in models from others
- Integration of legacy system models
- Combination of models of different depth and different formalisms in system-wide models of CPSoS, co-simulation, hierarchical modeling, appropriate levels of abstraction
- Meta-modelling and model management to ensure model consistency
- Modelling over the full life cycle of the system
- Combination of model- and data-based optimization
- Economic / socio-technical modelling

System integration and dynamic reconfiguration

- Dynamic requirements engineering
- Plug-and-play integration and live removal of components
- Configuration control
- Incremental live validation of modifications to the system
- Integrated engineering over the full life-cycle
- Reference architectures, open platforms and easy-to-test interfaces for integration, semantic integration to simplify the interactions of existing systems as well as the deployment of new systems
- Standardization
- Demonstrate industrial business cases and application of tools

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

Robust distributed system-wide control and optimization

- Decision structures and system architectures
- Coordination mechanisms for systems with autonomously managed units
- Understanding how the management and control structure (centralized, hierarchical, distributed, clustered) influences system performance and robustness
- Dealing with uncertainty, neglected couplings, stochastic effects, user interactions
- Combining model-based and data-based optimization
- Involvement of humans

Resilience in systems of systems

- Strategies for system-wide fault detection and mitigation
- Run-time verification
- Mechanisms for the detection of abnormal states and fail-soft mechanisms and fault tolerance
- Integrated cross-layer handling or disturbances and break-downs
- Advanced monitoring of the state of the system and triggering of preventive maintenance to improve long-term performance
- Interaction of monitoring systems, trust in diagnostic systems

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

Human in the loop

- Filtering and appropriate presentation of information to human users and operators for the acceptance of advanced computer-based solutions
- Investigation of the human capacity of attention and of measures to provide motivation for sufficient attention and consistent decision making
- Avoiding information overload
- Monitoring of the actions of the users and anticipating their behaviours and their situation awareness
- Analysis of the cognitive models of system operators
- Social phenomena (the dynamics of user groups)
- Combination of the capabilities of humans and algorithms in real-time monitoring and decision making (collaborative decision making and control, e.g. autonomous cars)

Towards cognitive systems: data-based system operation

- On-line data stream analysis to monitor the system performance, to detect faults and degradation, and to identify characteristic situations
- Combination of (semi-)rigorous and data-based models
- Data-based prediction and its use for control and optimization (purely data-based prediction, not fitting mathematical models to data and then using them)
- Visualization of the results of online data analysis
- Automatic reconfiguration and adaptation, learning good operation patterns from past examples
- Trust in data

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

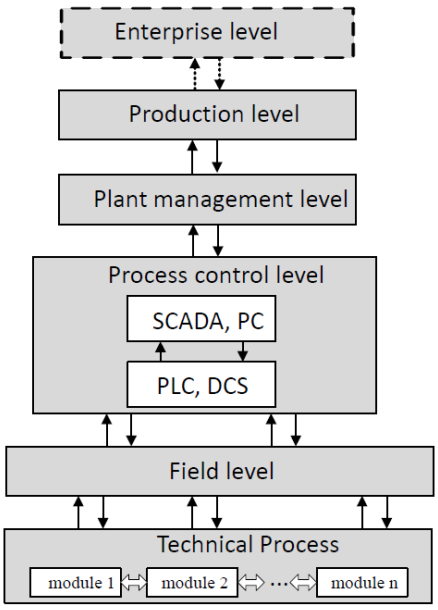
Towards a European Roadmap on Research and Innovation in Engineering and Management of Cyber-Physical Systems of Systems

Process industries

www.cpsos.eu

Integration of control, scheduling, planning and demand-side management

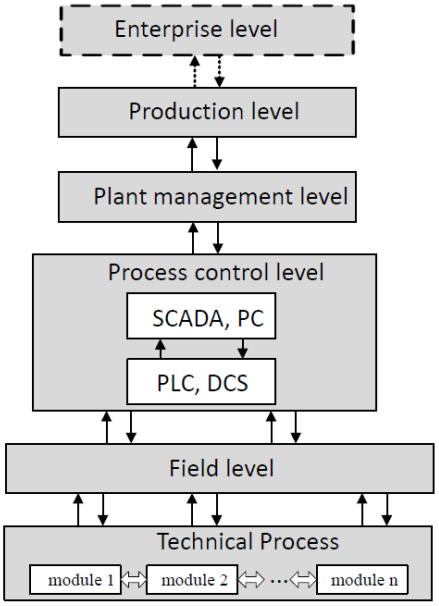
- Integration of control, scheduling, planning and demand-side management of industrial production systems / smart buildings
- Trans-layer integration (including model integration) inside the production system
  - Plug-n-play solutions to harmonize the communication across SAP(ERP) / MES / APC, data synchronization
  - Exchange of information between models on different levels
  - Integration of different software tools used at different levels



This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

Integration of control, scheduling, planning and demand-side management

- Demand-side management strategies, interaction of large consumers with the grid
- Mechanisms for achieving system-wide optimality (economic/regulatory mechanisms for minimizing the CO_2 footprint)
  - Multi-stage decision making under uncertainty



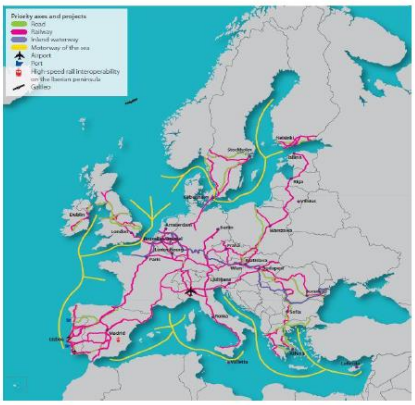
Towards a European Roadmap on Research and Innovation in Engineering and Management of Cyber-Physical Systems of Systems

Transport and Logistics

www.cpsos.eu

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

Development and exploitation of ICT to support multi-disciplinary, multi-objective optimization of operations in complex, dynamic, 24/7 systems (1)



Needs

- Improve capacity, efficiency and reduce cost
- Maintain continuous operation and provide resilience to disruption and failures
- Reduce emissions

- **Capacity, Efficiency and Cost Reduction** - Much of the transport infrastructure already exists. To increase capacity and avoid congestion there is a need to use existing infrastructure more efficiently. To support this here is a need for forecasting and coordinated control among subsystems and optimal routing for dynamic traffic networks. Increasingly multi-modal traffic is being considered. In the rail domain, for instance, the end-to-end journey time and ease of travelling for the passenger is a key factor. The rail segment is only part of the complete journey and there is a need to be able to model multi-modal traffic and also the passengers as they move between transport modes.

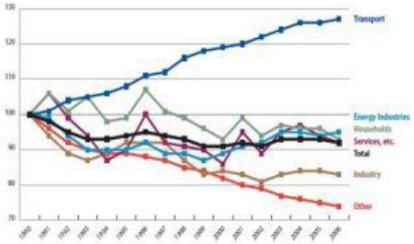
Development and exploitation of ICT to support multi-disciplinary, multi-objective optimization of operations in complex, dynamic, 24/7 systems (2)

Continuous Operation/Resilience

- ICT and remote connectivity to assets introduces the ability to perform increased "on condition" monitoring through deployment of sensors everywhere. This is expected to bring huge savings in maintenance of infrastructure and also more reliable operation of cars, trucks, aircraft, ship and trains.
- Component systems will inevitably fail, may be unavailable for periods of time or only offer degraded performance. To support continued operation the Systems of Systems need to be resilient with requirements for dynamic and self-configuration.
- At an individual vehicle level there is a need to build in fault tolerance to situations that may arise such as a vehicle stopping unexpectedly or not following the "rules" of the rest of the system.
- A key challenge for the future is data management. This needs to address the data deluge problem via large-scale online data integration and analysis of heterogeneous data sets to extract information. Real-time data acquisition and visualization tools are also needed to present a view of the "real-world in real-time". Supporting this there is a need for data exchange standards that allow the seamless integration of systems and provide interoperability. Challenges here are heterogeneity in the data but again also in maintaining security and privacy.

Emissions

Consumer demand and government regulation are driving the transportation sectors to use less energy overall, emit fewer harmful. CO_2 emissions targets are spelled out in the Copenhagen accord of 2009, with the EU offering to increase its emissions reduction to 30% (from 1990 levels) by 2020. To achieve this operators are now turning to Systems of Systems thinking to optimise the use of assets to minimise fuel costs and emissions.

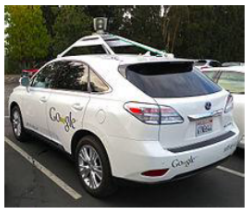


This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

Safe, Secure and Trusted Autonomous Operations for Systems with Humans in the Loop (1)

Increasing levels of automation/autonomy are being pursued in all transport sectors:

- Aerospace sector is currently leading in this field with autonomous vehicles already deployed for many years driven by military applications and enabled by the controlled nature of airspace.
- Cars are expected to introduce autonomous features by 2015.
- Rail industry plans roll out by 2024.
- Maritime industry ships are becoming increasingly more autonomous and a major new area that is developing is monitoring of the Earth and the oceans.



Safety is paramount in all transport operations

- With the increasing numbers of vehicles being operated the probability of accidents and fatalities becomes a significant issue. US/EU have set aggressive targets (e.g. halving on roads) for reducing loss of life and limb.
- Automated and semi-automated systems are being deployed across multiple transportation domains to improve safety. This is driving the introduction of increased communication between vehicles, between vehicles and infrastructure and the introduction of autonomous functionality.
- In the future there will be a much higher reliance on communication technologies between vehicles integrating both manned and autonomous vehicles in the same airspace, rail networks, marine environments and on the roads. Here there is a need for interoperability, guaranteed quality of service and security of communications.

Safe, Secure and Trusted Autonomous Operations for Systems with Humans in the Loop (2)

Approaches to system wide control and coordination are required

- Increasingly autonomous decision making will be introduced and this introduces sociotechnical issues about what systems should be made autonomous and what should be left to the human operator.
- Here there is also a need for homogeneous HMIs that allow users to interact easily and effectively with the system.
- Societal acceptance will be a key challenge. Trust is key and if a malicious entity managed to break into the system and cause an accident there would be a total loss of public confidence. Systems thus need to be secure but also need to fail safe even in the presence of a security breach (for instance one cannot shut down an aircraft engine if a security breach is detected).
- Privacy is also a key issue and increasing interconnectivity results in a potential loss of privacy. This is complicated by different national attitudes towards privacy in Europe.
- Lability needs to be carefully considered to ensure that citizens, manufacturers and operators have a clear framework in which to legally handle the consequences of the inevitable accidents when they happen.

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.

Manufacturing Systems

- New ICT infrastructures for adaptable, resilient, and reconfigurable manufacturing processes
  - Seamless and low-effort reconfiguration of manufacturing systems for fast adaptation to changing customer demands
  - Self-adaptation of production machines and robots
  - Semantic system integration of decentralized manufacturing systems across the complete value chain
- Data and information visualization for decision support in manufacturing
  - Automatic extraction of crucial indicators from large amounts of data
  - New HMI paradigms for responsive data visualization to maximize the real-time situational awareness of human operators

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 611115.