Report on Cyber-Physical Systems (CPS) Roadmapping Workshop

*Deployment CPS and IoT Technologies to support Digital Transformation*

*on the 20th of June 2018 at the 23rd ICE/IEEE ITM Conference, Stuttgart, Germany*

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1. Workshop aim and agenda

The Cyber-Physical Systems (CPS) Roadmapping workshop held on the 20th of June at the ICE/IEEE ITM Conference, Stuttgart, Germany was organised by the Platforms4CPS partner Steinbeis 2i GmbH involving 13 participants. The interactive workshop followed an introduction of the project and its themes, it was designed to validate and discuss future CPS related missions and priorities, recommended to be considered by the EC for the upcoming calls and next Framework Programme.

This Roadmapping Workshop was set to discuss trends and visions in the area of Digital Transformation such as Cyber-Physical Systems (CPS) and the Internet-of-Things (IoT) and their deployment in different application domains. The interactive workshop focused on emerging technology fields and related research priorities to fuel the development of trustworthy CPS/IoT, as well as needs and barriers for a successful implementation in different application domains (manufacturing, transport, energy and health). Participants identified (cross-)domain needs and requirements and developed a CPS/IoT ‘Technology Radar’ to draw recommendations for future research and innovation activities. The workshop gathered conference participant including CPS/IoT-experts from industry, academia and policy-making, which elaborated on specific ‘future missions’ combining technological developments and societal needs to meet future challenges. The workshop was supported by the Platforms4CPS Project (co-funded by the EC under the H2020 program) and will count on the knowledge and experience of experts in CPS/IoT and related technologies and applications.

Structure:

- **Introduction**: The European Digitization Strategy
- **Visions**: What are the trends and needs regarding society and different application domains in terms of Digital Transformation?
- **Technology Radar**: Which are the emerging technologies supporting digital transformation, with focus on CPS and IoT technologies?
- **Missions**: Where do we want to go? What are the players / the ecosystem to involve and how can we accomplish a development towards a ‘better future’.
2. **Proceedings and outcome of the workshop**

### 2.1 Welcome and Introduction

Meike Reimann, Senior Project Manager at Steinbeis 2i GmbH welcomed all participants to the Platforms4CPS Cyber-Physical Systems (CPS) Roadmapping workshop at the ICE/IEEE ITM Conference in Stuttgart. She briefly presented the project objectives and domains and gave a definition of Cyber-Physical Systems (CPS). As a basis for the workshop discussion, she introduced the following topics:

- **CPS trends and challenges** (e.g. trends like digitisation of economy & increasing connectivity; e.g. challenges like human-machine collaboration, business model, cyber safety and security)
- **Consensus Themes** (Research Priorities, Emerging Themes and Implementation)
2.2 Interactive Session

2.2.1 Missions

Stimulated by the platforms4CPS presentation, the participants were asked to propose CPS related missions for the next research program. The missions were written on post-it, explained to the other participants and placed and clustered on a poster. Meike Reimann summarised the findings and compared them to the previous workshop finding.

Table 1 FP9 Missions clustered according to themes

<table>
<thead>
<tr>
<th>Themes</th>
<th>Missions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate/Environment</td>
<td>The reduced waste factory: supportive by-products and waste management within and outside the company to achieve near zero resource waste.</td>
</tr>
<tr>
<td>Waste/Recycling</td>
<td>Reducing ecological footprint (CO2 emission, resource consumption...) of European production using CPS</td>
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<tr>
<td>Energy</td>
<td>Smart cities (Carbon neutral cities, reduction of energy wage, energy harvesting)</td>
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<tr>
<td></td>
<td>CPS for energy efficient manufacturing processes</td>
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<tr>
<td></td>
<td>50 % Reduction of energy consumption of household by 2030</td>
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<tr>
<td></td>
<td>Zero energy factories by 2030</td>
</tr>
<tr>
<td>Industry/Manufacturing</td>
<td>No prototyping, direct from the design to the product.</td>
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<tr>
<td></td>
<td>CPS for efficient monitoring management throughout the supply chain especially for manufacturing.</td>
</tr>
</tbody>
</table>
Cluster the results of table 1, the CPS related Missions focussed on:

- **Environment, energy and the climate challenge**: CPS could help in reducing emissions, waste and other pollution as well as energy consumption, paving the way for a low-carbon more circular economy. Creating smart cities and smart factories should help to reach those ambitions.
- **Transport**: CPS could enable autonomous vehicles
- **Manufacturing**: Should reduce the time to market
- **Health and quality of life** improved by CPS for elderly and by remote health monitoring/diagnosis.
- **Societal and Education**: Lifelong training, collaboration with robots and information will change the citizen’s way of working and living.

### 2.2.3 Assessment of CPS Themes and related Impacts

The participants were asked to asses different CPS themes for their impacts, related threats and need for funding under a CPS related program. The following themes were available:

- Safety, Security, Privacy, Trust
- CPS Platforms and Interoperability
- CPS Architectures
- (Virtual) CPS Engineering
- Autonomous CPS and Robotics
- Data Analytics and Decision Support (including Communication and Computing)
- HMI, Human in the Loop

The question posed was, which CPS technology...

- has the highest business impact (two votes per person)
- has the highest societal impact (two votes per person)
- represents the biggest threat (two votes per person)
- should be founded by the EU most urgently (two votes per person)

The results of the vote can be seen in the following Table 2
The assessment of different CPS related fields revealed very interesting results, confirming well the findings of the Platforms4CPS roadmapping activities. The strongest business impact was perceived in the fields of “data analytics & decision support” (38% of total votes) and “autonomous CPS” (25%). According to the participants, the most positive societal impact can be achieved by developing concepts and technologies around “Human Machine Interaction/human in the loop” (44%).

“Safety security, privacy and trust” is seen as the biggest threat (40%) far in front of the other technologies. The participants would like to see, the “Safety security, privacy and trust” (28%) and the “CPS-platform & interoperability” (28%) topics funded as a priority by the EC under a CPS program followed by “(virtual) CPS/IoT engineering” (17%) and “HMI / Human in the loop” (14%). In summary, “data analytics and decision support” and “Human Machine Interaction/human in the loop” revealed to be perceived to have the most positive overall impacts (adding business and social impacts), as well as being the most CPS related of the above fields and was proposed to be prioritised for future funding by the experts.

2.2.4 Elaboration of Technology Radar

The goal of this session was to explore CPS emerging technologies and research priorities in specific fields to derive recommendations for future research programs focusing on timeframes from today until 2020, between 2020 and 2030 and beyond 2030. Each participant received a document with the following Figure 4 and where asked to complete and modify it if necessary. The radar was widely accepted. Comments included new additions, rephrasing or moving of statements regarding timelines. Their inputs have been collected and will be included in the final Platforms4CPS roadmap.
4. Concluding Remarks

The workshop brought together experts, from a varied cross-section of domains (mainly academics), with an interest on Cyber Physical-Systems, to discuss missions, technologies and priorities in this context, to draw recommendations for the future research program.

Regarding the mission, environment, energy, transport, smart manufacturing, health, quality of life and education are themes that are included in the actual grand challenges defined by the European commission, it can be noticed that they are also partially present in the top CPS application domains identified by the former Horizon2020 funded Road2CPS project, the ECS SRA and the HIPEAC vision.

The trends identified by the voting: threat coming from safety security, privacy and trust issue, big societal impact of HMI/human in the loop, high business impact of data analytics and decision support are also confirmed in the latest CPS related roadmap (Platforms4CPS, ECS SRA and the HIPEAC vision).

The Platforms4CPS consortium thanks all participants for their valuable contributions as well as fruitful and open discussions!
## 5. Participants of the workshop

*Table 3 Workshop Participants*

<table>
<thead>
<tr>
<th>Name</th>
<th>First Name</th>
<th>Company / Organisation</th>
</tr>
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<tbody>
<tr>
<td>1 Bageritz</td>
<td>Steve</td>
<td>Steinbeis 2i GmbH</td>
</tr>
<tr>
<td>2 Barni</td>
<td>Andrea</td>
<td>SUPSI</td>
</tr>
<tr>
<td>3 Barreto</td>
<td>Luis</td>
<td>esce</td>
</tr>
<tr>
<td>4 Bertetti</td>
<td>Massimiliano</td>
<td>Polo tecnologico di pordenone</td>
</tr>
<tr>
<td>5 Brunet</td>
<td>Adrien</td>
<td>Steinbeis 2i GmbH</td>
</tr>
<tr>
<td>6 Ceci</td>
<td>Andreas</td>
<td>CRIT S.R.L</td>
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<tr>
<td>7 Eisenträger</td>
<td>Marlene</td>
<td>Fraunhofer IFF</td>
</tr>
<tr>
<td>8 Martens</td>
<td>Ingo</td>
<td>Hanse aerospace</td>
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<tr>
<td>9 Raule</td>
<td>Nicola</td>
<td>CRIT S.R.L</td>
</tr>
<tr>
<td>10 Reimann</td>
<td>Meike</td>
<td>Steinbeis 2i GmbH</td>
</tr>
<tr>
<td>11 Riad</td>
<td>Maha</td>
<td>The british university in Egypt</td>
</tr>
<tr>
<td>12 Sala</td>
<td>Alessandro</td>
<td>Fraunhofer Austria Research GmbH</td>
</tr>
<tr>
<td>13 Zangiacomi</td>
<td>Andrea</td>
<td>CNR ITIA</td>
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