Towards EU-US Collaboration on the Internet of Things (IoT) & Cyber-physical Systems (CPS)

Christian Sonntag
Senior Researcher & Project Manager, TU Dortmund, Germany
Support action, co-financed by the EC in H2020

GA no. 687874, total EC contribution: 999,719 €

Mission: Enhance EU-US ICT research and innovation collaboration to address societal challenges and industry needs and to enable economic growth in both the EU and US

ICT pre-competitive RDI: Key enabling technologies - 5G networks, Big Data, IoT/CPS

Policy: Forum for discussion and contribution to the debate on privacy, security, interoperability, ethics, ...

Application domains: Smart production, smart cities, smart transport, smart energy, ...

Duration: Jan. 2016 - June 2018

Web: http://www.picasso-project.eu
All public PICASSO reports are available at: http://www.picasso-project.eu/outreach/
Convergence of IoT and CPS

Focus of current research and development in IoT
- Low-cost sensors / computing
- Provision of connectivity, middleware
- Enormous amounts of data can be collected

How to make use of the data is sometimes not clear
- What benefits can be gained from the data
- Challenge: From sensing to actuation, closing the loop

IoT is an enabling technology for CPS → CPSoS

Beyond connectivity
- How can the data be transformed into useful knowledge and actions?
- Multiple / multiscale feedback loops, local autonomy in CPSoS
- Strong involvement of (and need for) humans

All public PICASSO reports are available at: [http://www.picasso-project.eu/outreach/](http://www.picasso-project.eu/outreach/)
## Comparison of EU and US RDI Priorities for CPS

### Significant overlap between the EU and the US

<table>
<thead>
<tr>
<th>High priority</th>
<th>EU</th>
<th>CPS</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 (Systems) engineering support</td>
<td></td>
<td></td>
<td>Model-based systems science and engineering</td>
</tr>
<tr>
<td>7 Trust, (cyber-)security, robustness, resilience, and dependability</td>
<td></td>
<td>Privacy, cyber-security, trustworthiness</td>
<td>2</td>
</tr>
<tr>
<td>4 Seamless integration, interoperability, flexibility, reconfiguration</td>
<td></td>
<td>System integration and interoperability</td>
<td>1</td>
</tr>
<tr>
<td>1 Autonomy and humans in the loop</td>
<td></td>
<td>Autonomy and human-computer interaction</td>
<td>1</td>
</tr>
<tr>
<td>3 Situational awareness</td>
<td></td>
<td>Situational awareness, diagnostics, prognostics</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lower priority</th>
<th>EU</th>
<th>CPS</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Validation, verification, and computation of key properties</td>
<td></td>
<td></td>
<td>Validation, verification, and certification</td>
</tr>
<tr>
<td>7 Distributed, reliable, and efficient management, control, and automation</td>
<td></td>
<td>Prototypes and test beds</td>
<td>2</td>
</tr>
<tr>
<td>0 Open R&amp;I environments, test beds</td>
<td></td>
<td>Distributed control</td>
<td>4</td>
</tr>
<tr>
<td>1 Reference designs and architecture principles</td>
<td></td>
<td>Open reference architectures</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Education and training</td>
<td>0</td>
</tr>
</tbody>
</table>

The number of funded projects is shown in green.

All public PICASSO reports are available at: [http://www.picasso-project.eu/outreach/](http://www.picasso-project.eu/outreach/)
Relating CPS and IoT Priorities

CPS

High priority

Integration, interoperability, flexibility, reconfiguration
Model-based systems engineering
Trust, (cyber-)security, privacy, resilience, dependability
Autonomy and humans in the loop
Situational awareness, diagnostics, prognostics

Lower priority

Management, control, and automation
CPS reference designs and architecture principles
Validation, verification
Open environments, test beds

IoT

High priority

Interoperability and integration
Closing the loop, IoT as an enabler for CPS
(Cyber-)security, privacy, resilience to platforms, innovation

Promising technology themes for EU-US collaboration

All public PICASSO reports are available at: http://www.picasso-project.eu/outreach/
Technology Themes - Overview

- **Closing the Loop in IoT-enabled Cyber-physical Systems**
  - System-wide control via IoT-connected devices
  - Data-based operation
  - Control architectures for IoT-enabled CPS
  - Performance and stability in the face of unpredictability (outages etc.)

- **Integration, Interoperability, Flexibility, and Reconfiguration**
  - Semantic interoperability and semantic models
  - Openness and open standards, harmonization
  - Automatic (re-)configuration and plug-and-play
  - Shared infrastructure, large-scale pilots
  - Architectures and cross-domain infrastructures

- **Model-based Systems Engineering**
  - Integrated, virtual, full-life-cycle engineering
  - High-confidence CPS, validation, verification, risk analysis and risk management
  - Models of heterogeneous large-scale systems

- **Trust, (Cyber-)security, Robustness, Resilience, and Dependability**
  - Fault detection and mitigation
  - Trustworthyness of technical systems
  - Behavior-based methodologies for trust
  - New engineering perspectives
  - Secure real-time and mixed-criticality systems

- **Autonomy and Humans in the Loop**
  - Autonomy in open systems that are not domain/knowledge-“contained”
  - Models of autonomous systems and humans
  - Humans in the loop / collab. decision making
  - Analysis of user behavior
  - Analysis, visualization, and decision support

- **Situational Awareness, Diagnostics, Prognostics**
  - Large-scale data analytics, management
  - Machine learning, adaptive behavior
  - Predictive maintenance
  - Self-diagnosis tools

All public PICASSO reports are available at: http://www.picasso-project.eu/outreach/
Barriers for EU-US Collaboration

- **Structural differences in funding environments**
  - Centralized EU funding vs. decentralized US funding, different spans of TRLs targeted, long time between application and funding can be problematic for companies, implementation time differences between EU and US funding initiatives

- **Administrative overhead and legal barriers**
  - Heavyweight mechanisms not promising, too much overhead and political resistance
  - Legal requirements (e.g. signing of CA, GA) problematic, lightweight MoU/contracts needed (new Implementing Arrangement seen as positive)

- **Lack of clarity of the benefits of EU-US collaboration**

- **Restrictions due to Intellectual Property protection**
  - Collaboration difficult on topics of high near-term commercial importance

- **Lack of joint EU-US funding mechanisms and policies**

- **Export control and privacy restrictions**

- **Lack of awareness and knowledge**

All public PICASSO reports are available at: [http://www.picasso-project.eu/outreach/](http://www.picasso-project.eu/outreach/)
Enhancing EU-US Collaboration

Roadmapping and benefit assessment, e.g. via joint, thematic EU-US workshops to

- Bring together a diverse group of experts from academia, industry, and government, foster government-to-government discussions about collaboration opportunities
- Identify and discuss specific R&I topics and concrete technology and application scenarios
- Clarify benefits that justify the additional effort of collaboration actions

Facilitation of collaboration initiatives

- Establishment of mechanisms/organizations that serve as central contact points, coordinators, and facilitators for EU-US collaboration actions and that provide support to potential partners (e.g. universities, companies, industry associations)

Lightweight joint research and innovation

- Joint calls, joint funding seen as infeasible, but coordinated calls / twinning promising
  → Set-up of a joint, targeted EU-US collaboration work programme, encouraging (lightweight) collaboration items (exchanges, knowledge transfer)
- Use of fellowship and exchange funding programs
- Launch of synchronized initiatives to support joint experimentation, new testbeds and demonstrators, and industrial standardization activities
  * Encourage contributions by companies, industry associations

All public PICASSO reports are available at: http://www.picasso-project.eu/outreach/
Thank You

Download our opportunity report here:

www.picasso-project.eu/outreach/project-reports/

Christian Sonntag, TU Dortmund, Germany