Cyber-Physical Systems Lab: a new research centre in CPS engineering
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Cyber-Physical Systems (CPS)
Cyber-physical systems comprise collaborating computational elements controlling physical entities, which interact with humans and their environment. Development of cyber-physical systems presents key engineering challenges:
• CPSs are large and complicated, with computational capabilities embedded in physical components.
• Control is distributed geographically, requiring scalable network technology.
• CPSs must execute dependable operations and tolerate both component and communication faults.
• CPSs need a capacity for dynamic reconfiguration, adapting performance based on environmental change.
• CPS design requires multi-disciplinary solutions, where each discipline has their own culture, paradigms and tools.

Objectives
• Develop scientific, well-founded methods and tools for modelling and verification, including fault tolerance and security, enabling collaborative development of CPSs across disciplines to increase confidence and reduce development time and maintenance costs.
• Work closely with industry to enable innovation and facilitate exploitation of CPlab outputs by acting as a design and research centre.
• Continuously evaluate and enhance CPlab design technologies through the industrial collaborations and CPS experiments.

Applications
DEPENDABLE SMART GRID
Holistic design and validation of control functions to enable efficient integration of a high number of renewable energy resources in next-generation power grids.

INTELLIGENT USE OF TRANSPORT
Hybrid and electric vehicles will become a major component in future transport. Driver decision support for driving modes, routes and comfort will enable optimal use and encourage adoption.

SAFETY
The drive for increasing automation on metro trains places additional safety requirements on the infrastructure. Virtual development and verification of these safety critical systems will reduce design time and costs.

MORE ADAPTABLE AGRICULTURAL PROCESSES
Pressure on agricultural resources is increasing and drives the need for greater growing yields. The cost effective development and tests of automated, precise agricultural equipment can help meet these demands.

References

Focus on Digitally Enabled Urban Sustainability
CPlab will be co-located with new labs in a variety of areas relevant to Digitally Enabled Urban Sustainability, along with the Newcastle University School of Computing Science:
• Adjacent to an EPSRC-supported Smart Grid lab and the Mobility & Transport lab will allow us to research and calibrate models for dependability of software-rich infrastructure.
• Alongside new Centres for Doctoral Training in Cloud & Big Data and Digital Civics.
• Urban Observatory gathers in real-time sensed data from across Newcastle.
• A decision theatre to explore new ways of presenting CP data to decision-makers of all sorts.

UK Hub for a European Network of CPS Labs
CPlab is the UK Design Centre in the CPSE Labs network, a new Innovation Action under the EU’s Horizon 2020 programme. The network goals include:
• Foster an open, Pan-European network of design centres committed to transitioning science and technology for engineering trustworthy and dependable CPS into the marketplace.
• Identify and support experiments with innovation objectives including: value chain completion; transferring technology to a new domain; standardisation efforts, transferring technology to new use cases.
• Spread best CPS engineering practices and promote cross-regional and cross-sector learning among industry and academia.
• Establish a marketplace for CPS engineering assets.

Technologies
• Multi-disciplinary co-modelling
• Contract-based modelling
• Formal semantics
• Low-power & survivable computing
• Structured Occurrence Nets

METHODS
• Co-simulation
• Design Space Exploration
• Compositional Verification
• Model-checking, proof
• Architectural modelling
• Model construction guidelines
• Modelling patterns
• Fault Analysis

INTO-CPS
CPlab is part of the INTO-CPS project, a new Research & Innovations Action under the EU’s H2020 programme. Its goals include:
• Develop an open, well-founded, full development lifecycle, multidisciplinary tool chain
• Support the tool chain with practical methods, guidelines and patterns
• Demonstrate the effectiveness of tools and methods in an industrial setting

Acknowledgements & Contact Details
CPlab’s work is in part supported by upcoming European Commission H2020 actions, EPSRC Platform Grant on Trustworthy Ambient Systems (EP/R008133/1), and EPSRC SIREN grant (EP/K031678/1).

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References