BOSCH

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Bosch as a Cyber-Physical Systems stakeholder

CPS domains are strongly related to current and future products and services sold by Bosch in three business sectors[1]:

- Automotive Technology (€27.2B / $6.2B)
- Industrial Technology (€5.9B / $1.3B)
- Consumer Goods and Building Technology (€11.7B / $2.0B)

[1]Note: figures are expressed as sales worldwide in billion EUR / North America in billion USD for 2007

Transportation systems are an especially important area for Bosch, as automotive technology constitutes about 60% of Bosch sales. With strong embedded systems expertise in multiple sectors, the next step to CPS presents many interesting opportunities. With this diverse business portfolio, Bosch is interested in new technical developments and in exploring synergies among different CPS sectors.

Research challenges

Three important research challenges, discussed in previous workshops, include the following. These would fit under "Grand Challenges" or "Requirements" regarding workshop topics.

1) Predictable system integration through compositionality

Cyber-physical systems will include many functional and non-functional requirements. How can we define the responsibilities of individual components such that we can make guarantees about the entire system? Product lines are important – how can components be predictably reassembled into another product? How do we maximize re-use?

"Cyber" systems also typically operate under a different paradigm (transaction semantics, event-based, rollback for recovery) than "physical" systems (physical world is modified, real-time, redundancy to avoid failure). What is an appropriate bridge between the two?

2) Architectures and tools for reliable and resilient CPS systems

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CPS architectures are likely to be decentralized. A key question here is how to achieve the benefits of a centralized system (including quality assurance and globally optimized efficiency) while avoiding the disadvantages (which could include fault tolerance/security weaknesses and poor performance for individual stakeholders). What is the right way to divide control authority, and to allow data visibility (vs. aggregation)?

3) Verification and Validation (V&V) of model-based design

Future transportation systems may include autonomous driving, car-to-car communication, and other features that take advantage of smart environments and digital services.

Will there be any CPS "standards", for both the product and the design process? How can we attain confidence about the quality of a CPS system? CPS devices may come from many different suppliers, where there might not be a single company as "system integrator". How will one device operate with another previously unseen device?

Promising directions

Bosch engages in many research collaborations with individual universities and multi-university research centers. Some promising technologies related to CPS that we are currently investigating include:

- Cost-benefit and requirements analysis for software and software tools (Fraunhofer)
- Software model analysis and transformation (UC Berkeley)
- Middleware suitable for next generation wireless networks (USC)
- New physical sensors, especially MEMS (Stanford)

These and other collaborations show Bosch's commitment to the research community, and benefit as a research partner. We look forward to new opportunities in the Cyber-Physical Systems community.

Biography

Elizabeth Latronico has been a member of the Software Engineering group of the Research and Technology Center at Robert Bosch, LLC for three years. She received a Ph.D. (2005) and M.S. (2002) in Electrical and Computer Engineering from Carnegie Mellon University, and a B.S. (2000) in Computer Engineering from Case Western Reserve University.