

## **Thinking Across Domain Boundaries: A Composition Framework for Wireless**

### **Mission-Critical Cyber-Physical Systems (PI: Dr. Wang Qixin; 2014/15)**

Cyber-Physical Systems (CPSs) represent the convergence between the computing (discrete-time) and the physical (continuous-time) world, and CPS's are increasingly being deployed in mission-critical applications such as medical, transport and industrial automation. While the CPS design and usage space is very diverse, three key characteristics underlie most CPS designs: i) a CPS is typically composed of multiple smaller-scale CPSs; ii) wireless networks have become a type of indispensable infrastructure to provide mobility and flexibility; and iii) faults and errors are a major concern and detrimentally impact both the functionality and safety of CPSs. Unfortunately, the state of the art has each of these key characteristics handled in isolation resulting in inefficient design-from-scratch approaches for each CPS application.

As part of the effort to support the above characteristics with a systematic and efficient design approach for multiple CPS applications, this project proposes a composition framework for wireless mission-critical CPSs. The proposal specifically addresses the following challenges:

- **Challenge-1:** What principles underlie the design of a generic CPS composition architecture?
- **Challenge-2:** How to realize (and validate) the composition architecture with

cross-domain (discrete-time cyber domain and continuous-time physical domain) thinking, covering mission-critical design aspects of cross-domain abstraction, fault/error handling, and reliable real-time interaction composition?

- **Challenge-3:** How to conduct admission control and optimization?

As CPSs inherently entail involvement of the discrete-time cyber domain and the continuous-time physical domain, a cross-domain approach is fundamentally required and currently lacking in the community. Developing and validating such a cross-domain approach is the essence of this proposal.

Furthermore, we envision outcomes of this project to initiate fundamental rethinking on broader CPS design/analysis principles beyond composition: how to encapsulate data/fault in the cyber/physical environments? what are the principles of data/fault interfacing across domain boundaries? are existing design/analysis principles, strategies, methods, and tools on dependability/performance of computing systems still valid in the cross-domain context of CPS?