Abstract for Proposal 1035942: CPS:Medium:Collaborative Research: Dependability Techniques for Instrumented Cyber-Physical Spaces

The objective of this research is to develop semantic foundations, cross-layer system architectures and adaptation services to improve dependability in instrumented cyberphysical spaces (ICPS). The approach is based on the principles of "computation reflection" where information from heterogeneous sensing devices is used to create a digital representation of the evolving cyberphysical world for use by mission-critical applications such as infrastructure monitoring, and incident-site emergency response. These applications require the underlying systems to be ***dependable*** despite disruptions from failures in sensing, communications, and computation.

The digital state representation generated in the reflective architecture guides a range of adaptations at different layers of the ICPS (i.e. networking, sensing, applications) to achieve end-to-end dependability at both the infrastructure and information levels. Examples of techniques explored include mechanisms for reliable information delivery over multi-networks, quality aware data collection, semantic sensing/reconfiguration using overlapping capabilities of heterogeneous devices. Adaptations are driven by formal-methods based runtime analysis of component availability and application dependability needs.

Responsphere, a real-world ICPS infrastructure on the UC Irvine campus along with emergency response applications will serve as a testbed for development and validation of the "reflective" approach and the adaptation techniques for dependability. Students at different levels (graduate, undergraduate, K-12) will gain experience with developing real-world applications in the Responsphere ICPS via courses and independent study projects. Collaborations with first responder partners via drills/ exercises will expose stakeholders to technology innovations in a domain of national interest. Students will benefit tremendously from exposure to new software paradigms for future ICPS living environments.