Test-driven modeling and development of cloud-enabled cyber-physical smart systems

Embedded products currently tend to evolve into large and complex smart systems where products are enriched with services through clouds and other web technologies. The complex characteristics of smart systems make it very difficult to guarantee functionality, safety, security and performance. Using test-driven modeling (TDM) is likely to be the best way to design smart systems such that these qualities are ensured. However, the TDM methods that are applied to development of simpler systems do not scale to smart systems because the modeling technologies cannot handle the complexity and size of the systems. In this paper, we present a method for test-driven modeling that scales to very large and complex systems. The method uses a combination of formal verification of basic interactions, simulations of complex scenarios, and mathematical forecasting to predict system behavior and performance. We utilized the method to analyze, design and develop various scenarios for a cloud-enabled medical system. Our approach provides a versatile method that may be adapted and improved for future development of very large and complex smart systems in various domains.