

## Semantic Complex Event Processing for Smart Grid Information Integration and Demand Management

Qunzhi Zhou, Yogesh Simmhan and Viktor K. Prasanna  
Department of Computer Science, University of Southern California

The unceasing demand of energy is driving rapid transition of the power grid to a Smart Grid. The benefits of Smart Grid include demand-response applications that predict peak demand, provide dynamic pricing, and perform load control to improve the efficiency of power grids. The information for these decisions comes from diverse sources including smart meters that report near real-time power usage and quality, intelligent thermostats that measure and control buildings heat and humidity, and even weather forecast from online services.

In order for demand-response applications to take advantage of the large quantity of data influx, meaningful integration of data and combining them with prior knowledge is necessary. In this poster, we propose a solution to this crucial information integration problem using a combination of complex event processing (CEP) and Semantic Web technology, as part of the software architecture for demand-response in the Los Angeles Smart Grid Demonstration Project. We define an ontology model for Smart Grid information that captures relevant domain concepts and annotates available information with well-defined vocabulary terms that provide a context for their use. In particular, we define a hierarchical event abstraction over raw data. For example, while raw data might be in the form of power usage for a kitchen appliance generated every minute, a more semantically meaningful event modeled by our system could be the aggregate energy used in the entire kitchen at different time periods in a day. The latter is more useful for those building demand-response and higher-level applications using the semantic information we provide and allows it to be extended to other concepts like building layout, utility provider information, and even the daily schedule of house members. Demand-response relies on complex interactions between different entities in the Smart Grid. Our system models complex event patterns and event-based operations as queries and production rules on top of the integrated information model. The consequence of this is a more meaningful synthesis of structural Smart Grid data with better understanding of their relationships. Since the event data conforms to a formal semantics, domain experts will be able to encode their knowledge of meaningful event patterns and define responses to events using declarative languages. Realtime complex event processing can be performed to identify the most relevant event patterns from incoming event streams, analyze their impact, and take subsequent actions immediately. We plan to apply this approach to the demand management use cases to demonstrate its feasibility, advantages, and limitations.