A Data-Centric Information Architecture for Power Systems

Christoph Gerdes

Abstract

Over the last decades, changes in society, economy and technology have let to the emergence of new requirements for industrial systems. In the near future, new kinds of systems will appear that differ from their precursors by their inherent organisation and the kind and number of system entities.

In particular the size and heterogeneity of the new systems give rise to a high level complexity. In contrast to large-scale systems in other domains, e.g. media or communication, the industrial domain has particular (non-functional) requirements that must be addressed essentially.

A data-centric information architecture for large-scale industrial systems is developed to address the complexity issues. The architectural approach allows for a system model which is not top down engineered but rather implements a bottom-up design. Based on scenarios from present power systems, key requirements are identified and used to validate structures, methods and algorithms of the architectural design.

The thesis makes the following scientific contributions:

Concept: The concept of the Service Ecosystem for Energy Services provides a model for the creation and operation of large-scale power infrastructures. It provides methods for collaboration, communication and exchange. This concept for power infrastructures can be utilised also for other types of large-scale industrial systems.

Architecture: Motivation and elaboration of a data-centric architecture as foundation for distributed intelligence for large power networks. Closing the gap between lower level networking and control applications this approach lays the foundation for advanced control algorithms required, e.g., in de-central power generation context.

Data model: A minimalist canonical data model is developed which allows for communication and co-operation of individual entities.

Programming language: The Service eCoSystem Query Language (SCSQL) enables the declarative specification of information flows between entities. Furthermore large volume data streams can be pre-processed in-network reducing utilisation of the communication infrastructure.

Peer-to-Peer protocols: Transition of P2P protocols originally developed for data sharing in the Internet to the energy automation domain for monitoring and control purposes.