MASGRID: Multi-Agent coordination for decentralised management of energy distribution and storage in a Smart GRID

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Introduction

In [1], a smart grid is defined as a communicating power network whose elements are interconnected, not only physically by the means of voltage lines, but also virtually by the means of smart meters and other communicating equipments. The physical power grid is thus complemented by a virtual network of communications that employs the Information and Communication Technology (ICT) domain. Figure 1 shows the various energy sources that are integrated in the smart grid, as well as the ICT layer.

Advanced ICT solutions promise a wide variety of possible applications in the smart grid, which include: automated demand response, balancing services, dynamic pricing, and buying and selling of power in real time.

“The decentralized nature and expected autonomous, intelligent behaviour of the smart grid have much in common with the Internet” [2]. That is why ICT approaches are needed to build and manage the grid. In particular, multi-agent systems (MASs) constitute an appropriate technology for building distributed systems where autonomous, and possibly self-interested components, interact. In the literature, several multi-agent systems’ techniques and methodologies have been applied to the smart grid. Kamboj et al. [3], for example, make use
of the coalition formation theory in order to group electric drive vehicles (EDVs) for vehicle-to-grid power regulation. The smart grid will open the electricity market. The consumer will become a producer, and will be able to sell electricity back to the grid. Thus management techniques for the trading of electricity are required. In [4], the authors develop a market-based mechanism and trading strategies for the smart grid. Their work is based on the Continuous Double Auction. In [5], the PowerMatcher technology, a multi-agent coordination system, is considered for use in decentralized electrical power systems. The MAS is based on an electronic market where agents negotiate using strategies of microeconomics theory. Storage learning strategies that adapt to the electricity market’s conditions are presented in [6].

Previous work in our laboratory

In our team, we are interested in smart grids as we are already working on multi-agent aggregation of information collected by wireless sensor networks deployed in smart grid equipments [7]. In this work, our approach relies on the distributed and in-network processing of the information, prior to its transmission over the wireless channel. This will result in the reduction of the number of messages to be transmitted, and thus reduce packet loss and re-transmissions. Furthermore, enabling the different smart grid entities with enough intelligence to make local decisions related to specific applications, will allow us to put in place distributed control mechanisms. This will not only take the load off the electric utility’s control center, but will also require less wireless communications (which is vital in wireless sensor networks), and most importantly will allow quick responses to urgent situations.

Objectives of this project

The aim of this post-doctoral project is to propose a multi-agent architecture supporting dynamicity of users and efficiently exploiting information gathered from WSN. The originality of the proposed project lies in the fact that we approach smart grid domain from a cooperative multi-agent and communication network perspectives. Thus, on the basis of the aggregated information gathered by sensors and sent to the sink, (pro)consumers and providers will take the appropriate decisions concerning energy storage and distribution. This decision is made locally by each actor and will follow an algorithm which will be proposed by the candidate. In a network of distributed generation such as the smart grid, supply and demand matching constitutes a major issue that must be handled by the proposed algorithm. This algorithm must be tested (by simulation) and compared to other algorithms proposed in the literature.

Dates: Start in September 2012 for 1 year.
Preferred skills: Multi-agent systems, Coordination and negotiation algorithms, programming languages (JAVA, C)

References

