The CrocodileAgent 2012: Reaching Agreements in a Simulation of a Smart Grid Wholesale Market

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Abstract. Over the last few years electricity markets are going through liberalization and modernization processes, which have resulted in introduction of smart grids. The Power Trading Agent Competition (Power TAC) is a simulation platform for evaluating trading strategies for the smart grid electricity markets: the tariff and the wholesale market. This paper gives an outline of our proposed strategies for reaching agreements in the Power TAC wholesale market.

Keywords: smart grid, electric energy wholesale, negotiating agreements, bidding strategies

With the advent of smart grids, a growing need to maintain real-time balance between electric energy production and consumption emerges due to high cost of electric energy storage. Successful trading on the wholesale market is an important prerequisite for achieving that balance. In this paper we describe the wholesale market bidding strategies implemented in the intelligent software agent CrocodileAgent 2012 that acts as a broker in the smart grid power market simulator Power Trading Agent Competition (Power TAC) [1].

The Power TAC *Wholesale Market* is modelled as a periodic double auction which clears every simulated timeslot. In the Power TAC *Wholesale Market* brokers buy and sell electric energy at the market clearing price (i.e., equilibrium price). Brokers can simultaneously send orders (i.e., bids or asks) to 24 different markets, each representing one of the 24 upcoming simulated timeslots (i.e., day-ahead market). Broker's main goal is to ensure the sufficient amount of energy for customers in its portfolio by buying energy on the Power TAC *Wholesale Market* from producers and other brokers. In case of energy imbalance the broker must pay a balancing fee.

Modules of the CrocodileAgent 2012 are shown in Figure 1. The *Forecasting Module* uses historic data (e.g., past energy production/consumption, previous clearing prices) to predict the amount of energy customers will need in the next 24 timeslots and to estimate clearing prices on the Power TAC *Wholesale Market*. For calculating predictions we use the triple exponential smoothing technique better known as the *Holt-Winters Method* [2]. The predicted values are defined as:

$$predictedValues = f(\alpha, \beta, \gamma, x, period, m) \qquad (1)$$

where $\alpha, \beta, \gamma \in [0.0, 1.0]$ are parameters used to calculate the triple exponential smoothing of past values consisted in the parameter x (i.e., past clearing prices), the parameter $period$ is the periodicity of those values (e.g., daily periodicity – periodicity of 24 timeslots) while m is the number of values to be predicted.
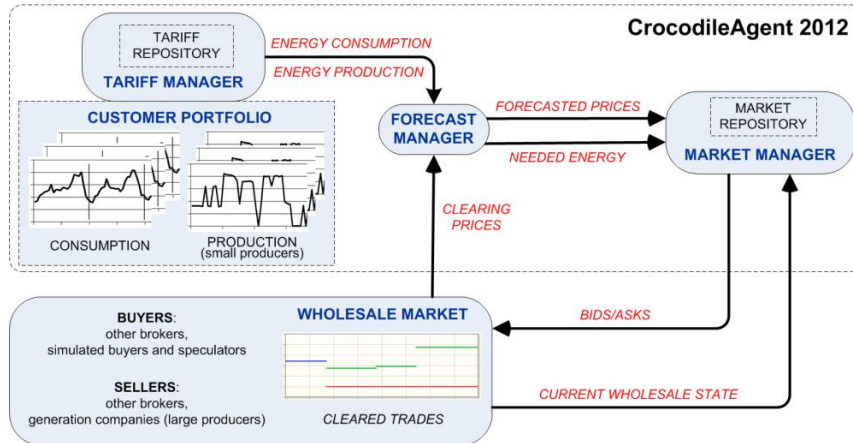

Fig. 1. The architecture of the CrocodileAgent 2012

The CrocodileAgent 2012 retrieves the information about the amount of energy it needs to buy or sell for each of the 24 upcoming timeslots and computes the price offered on the Power TAC *Wholesale Market* depending on the number of tries left (e.g., if the current timeslot is T_i and the broker wants to buy the energy needed for the timeslot T_{i+10}, it can do so by biding in the current and 9 upcoming timeslots). As the respective timeslot approaches, the CrocodileAgent 2012 increases the price it is willing to pay in order to buy the needed amount of energy. If there is only one try left (i.e., the current timeslot is T_{i+9}), the broker offers a predefined maximum price. More detailed description of the CrocodileAgent 2012 can be found in [3].

References

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