Enhancing scalability of Peer-to-Peer energy markets using adaptive segmentation method

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Market clearing method

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Segmentation

Market segmentation is one of the most fundamental strategic marketing concepts, which can be used to group players according to their similarity in several dimensions related to a product under consideration. Segmenting a market means dividing its potential consumers into separate sub-sets where players in the same group are similar with respect to a given set of characteristics. Cluster analysis allows reducing the number of observations, by grouping them into homogeneous clusters.

In the P2P energy trading, as there are a large number of players, market segmentation can be used to divide market to several segment, where in each segment only a few players with similar features negotiate for energy trading. In this paper, an adaptive segmentation method is proposed to divide a large scale market into several subgroups, where two important characteristics are considered to form segments; capacity (to secure trading amount), and price (to improve/minimize utility/cost). For each player i a bid vector ω_i is submitted to the market.

$$\omega_i = \{\bar{X}_i, \gamma_i\} \tag{1}$$

where, $\bar{X}_i$ and γ_i are maximum power and its corresponding price for player i which indicates a point of marginal cost/benefit curve of player. A set of N_s segments is generated before segmentation and players will be clustered in these typical segments separately. Historical data can be used to set initial segments. Determining the number of segments without prior information is a non-trivial and computationally expensive problem. The segmentation method used in this paper is distance-based, where market players are assigned to the different segments $j \in \{1, \ldots, N_s\}$. It should be noted that in each segment the total demand and supply should be balanced and this constraint need to be taken in account during the segmentation.

After assigning players to different segments, at the first step centroid of each segment is calculated by averaging parameters of all members in each segment. The centroid of segment jj is presented by (2)

Then, distance of all players with centroids is calculated and stored in a distance matrix. Distance parameter is obtained as

where, xx , are scaling factors. The distance matrix can be obtained by An allocation vector specifying to which typical segment each player is assigned to is generated using

These steps will repeat until there is no more new assignment.