Topic - Dynamic Load Scheduling

The problem concerns the dynamic scheduling of generation capacity and connected loads. Loads are modeled as a consumer of electrical power whose needs are parameterized by a *demand curve*, $D(\cdot;\cdot) : \mathbb{R}^+ \times \mathbb{R}^+ \to \mathbb{R}^+$. The demand curve takes values $D(t;t_0) \in \mathbb{R}^+$ which represents the total energy demanded by the load over the time interval $[t_0, t)$. let $P_d(\cdot) : \mathbb{R}^+ \to \mathbb{R}$ denote the *instantaneous power* demanded by the load where $P_d(t)$ is the instantaneous power demanded a time t. Then clearly, the demand curve can be written as

$$D(t;t_0) = \int_{t_0}^{t} P_d(\tau) d\tau$$

Each load (or group of loads) in the microgrid has a demand curve. The ith load's demand curve is denoted as $D_i(t;t_0)$ and the total load of the grid over $[t_0, t)$ is

$$D(t,t_0) = \sum_{i=1}^{N} D_i(t;t_0)$$

where N are the total number of loads that can be connected to the grid.

This function is continuous and an increasing function of time. We also introduce a *supply function* $S(\cdot;\cdot) : \mathbb{R}^+ \times \mathbb{R}^+ \to \mathbb{R}^+$. The supply function takes values $S(t;t_0) \in \mathbb{R}^+$ which is the maximum energy that can be delivered to the loads from all generation sources connected to the grid over the time interval $[t_0, t)$. If we let $P_{gi}(\cdot) : \mathbb{R}^+ \to \mathbb{R}^+$ denote the generation set point of generatior i at time time t, then the total energy available to the loads is simply

$$S(t;t_0) = \sum_{i=1}^{M} \int_{t_0}^{t} P_{gi}(\tau) d\tau$$

The function $S(t;t_0)$ therefore represents the total energy that could be delivered to the load. The function $D_i(t;t_0)$ denotes the total energy that would be demanded by the ith load. We assume that $S(t;t_0)$ has been determined on the basis of energy availability. The functions $D_i(t;t_0)$ have been determined by nominal energy demand for each load. Since the microgrid has little ability to store energy. We need to make sure that for a given supply curve, that we identify which loads can be connected so that

$$|S(t;t_0) - D(t;t_0)| < \epsilon$$

where $\epsilon > 0$ parameterizes the allowable mismatch between total demand and total generation capacity that can be handled by the low level CERTS controllers. Basically, this means that the change in frequency due to mismatch is within the tolerance levels for the system.

The controls we have to adjust the demand curves involves the decision of which flows to use. The proposal involves using timed automata for each load flow and then compose them together with respect to the parameterization of the model. Decision is then a "control" decision that is determined by first constructing a finite bisimulation of the automata models and then doing a search through the composed model to see if the maximum generation constraint is satisfied or not.