Energy Consumption Stabilization by Agent-Based Decentralized Tree Aggregation

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## 1. From Thermostatically Controlled Appliances to Software Agents

• **Why thermostatic devices:** 30% of the total consumption in the USA + space for autonomy
• Circuit controllers embedded in refrigerators, water heaters, air conditioners etc.

• Software agent runs in every device
• **Functionality:** Generation of equivalent energy plans (functions of energy consumption over time)
• **Goal**: Choice of the best plan ➔ the one that contributes optimally in the global stabilization

3. Stabilization by Oscillation Minimization

• Maintenance of the global stabilization in discrete and consecutive aggregation rounds
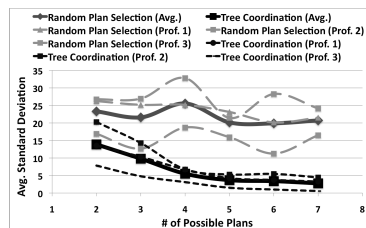
• **Adaptation on the aggregate plans:** Aggregators adapt the combinations to the aggregate plans that have been chosen so far

Problem

• **Load peaks in energy consumption lead to higher cost for suppliers and consumers**

Approach

• **Adaptive distributed coordination of agents' plans through decentralized hierarchical aggregation**

Results

• **Higher stabilization: (i) than random plan selection, (ii) as number of possible plans increases, (iii) as more agents are connected to the tree**

4. Stabilization by Reversing Oscillations

• Considering pre-existing oscillations in a global target plan over a period, plans are adapted to reverse them
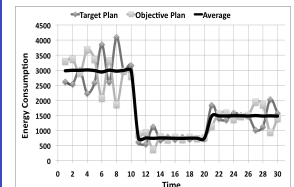
• **Adaptation on the target plans:** Aggregators adapt the combinations to the target plan that is gradually replaced by the new aggregated plans

2. Tree Aggregation and Agent Tasks

• **Aggregation step:** exchange of information between all parent-children links at a tree level
• **Aggregation round:** consecutive aggregation steps starting from leaves up to the root. Completed with information broadcast from the root to all nodes
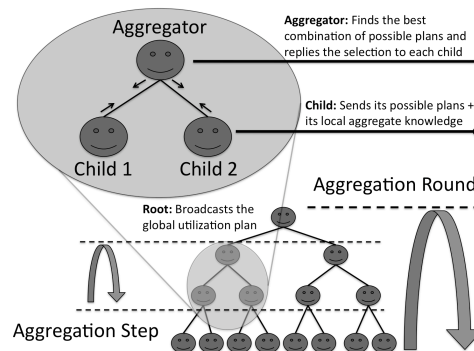
• **Agent Role**: Dual. *Requester* (child) of a choice for an energy plan and *aggregator* (parent) of requesters
• **Child:** Sends its possible plans + its local aggregate knowledge to its parent
• **Parent:** Generates the combinations of all the possible plans and chooses the best according to a fitness function. It updates its local aggregate knowledge and the process recurs