A Distributed Agent-based Approach to Stabilization of Global Resource Utilization

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Motivation

From **local resource utilization** to **global resource stabilization**

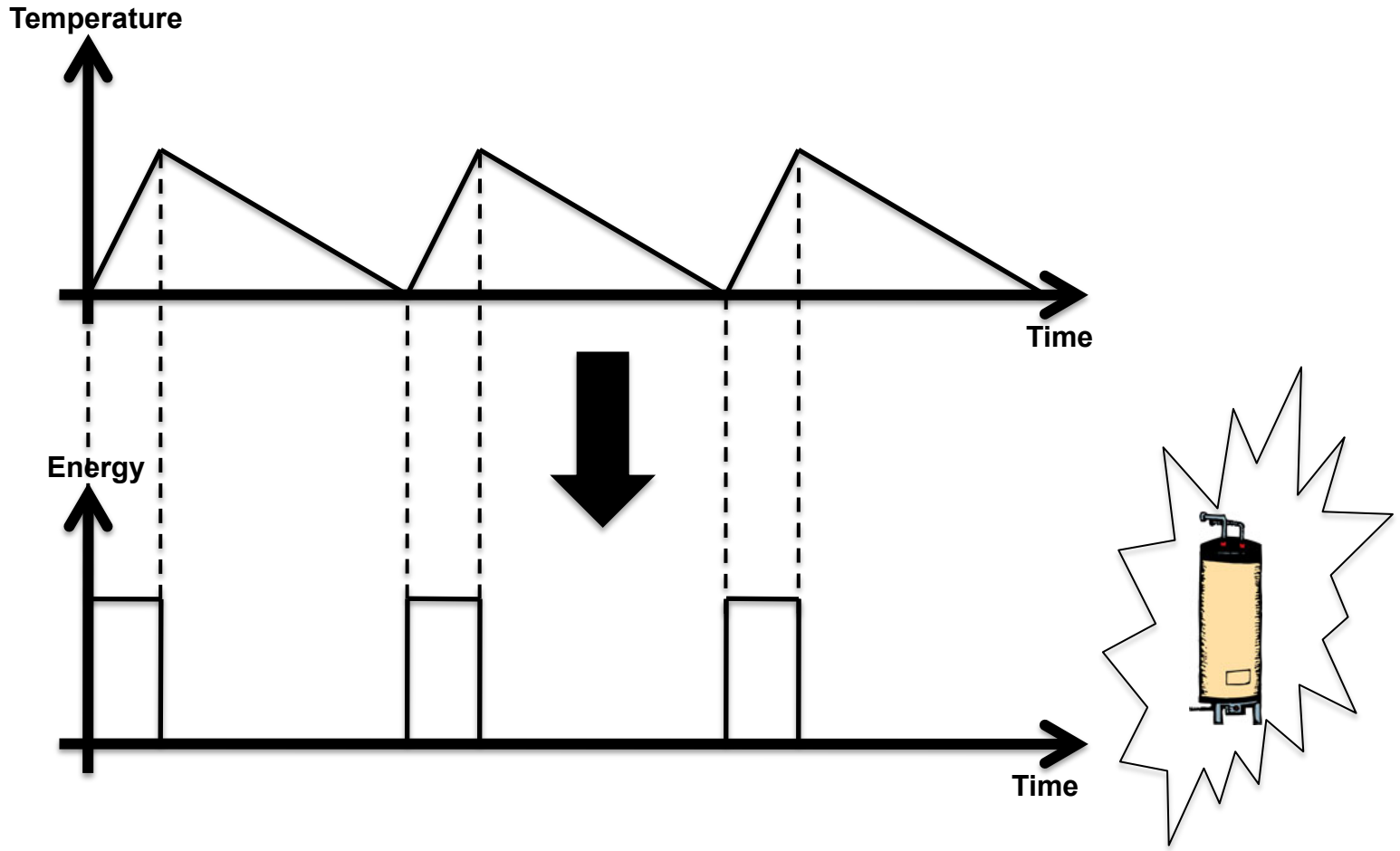
Challenge..!

Motivation (cont.)

Resource allocation problem?

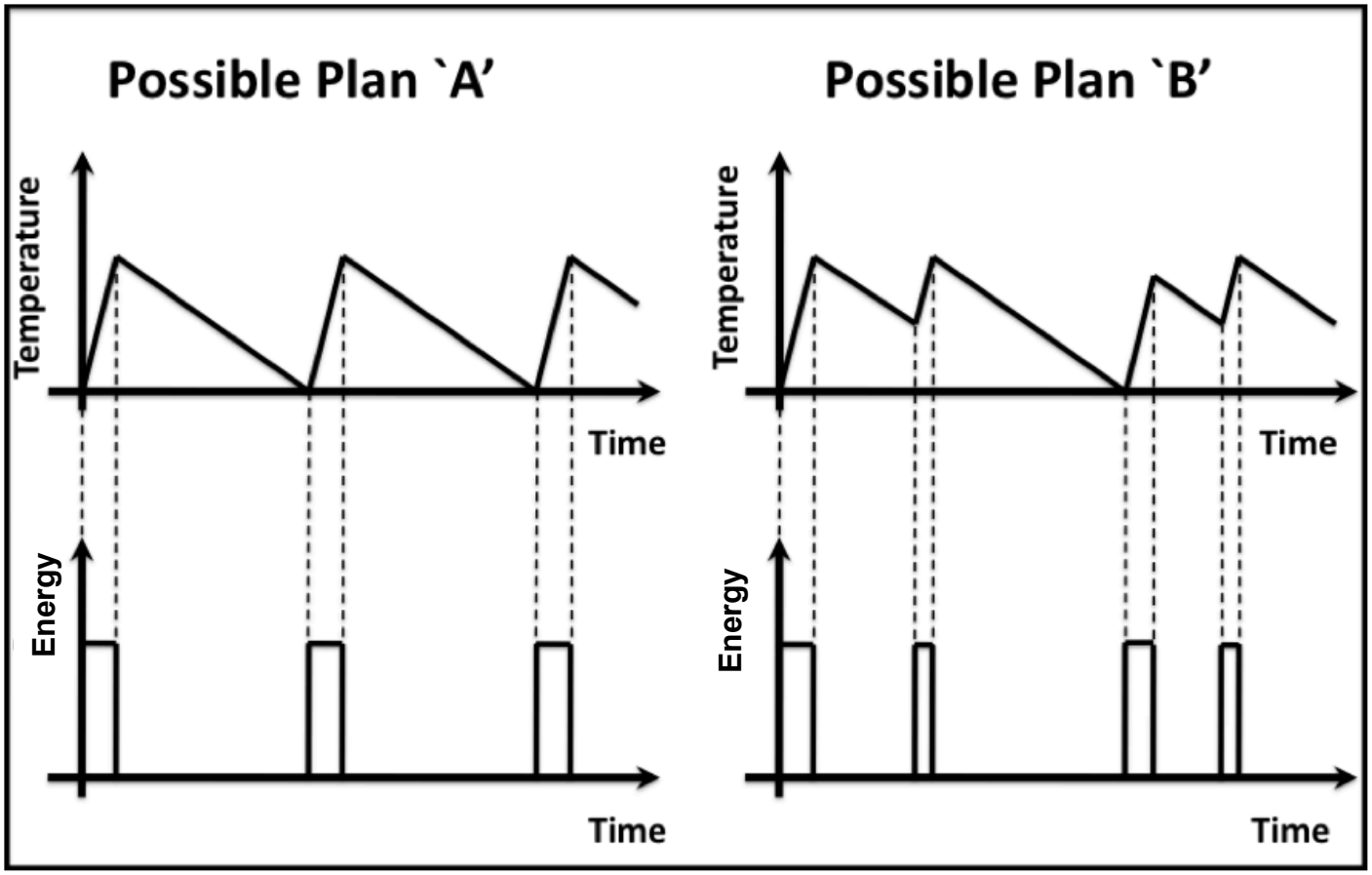
Resource Allocation Problem

Energy plans generated and executed by **thermostatic devices**



Resource Allocation Problem

The **selection process** from a set of locally generated **possible plans**



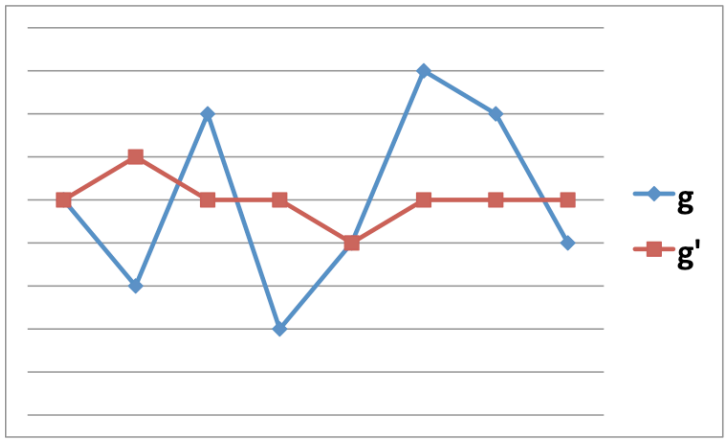
Resource Allocation Problem

How to achieve **global stabilization** in energy utilization

Self-stabilization

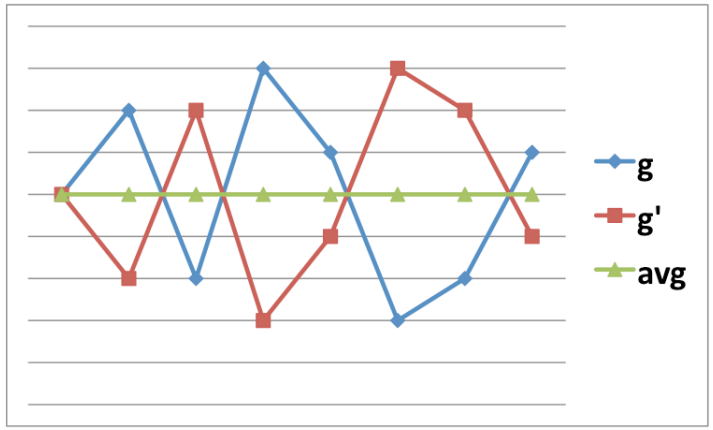
Minimum Deviations

Keeping the oscillations to the minimum continuously



Reversing Deviations

Balance a sudden unavoidable peak in the system in a next period



Problem Overview

Distributed – flow resource – coordination problem!

Research Question

How can the **local plan selections** result in a **global stabilized plan**?

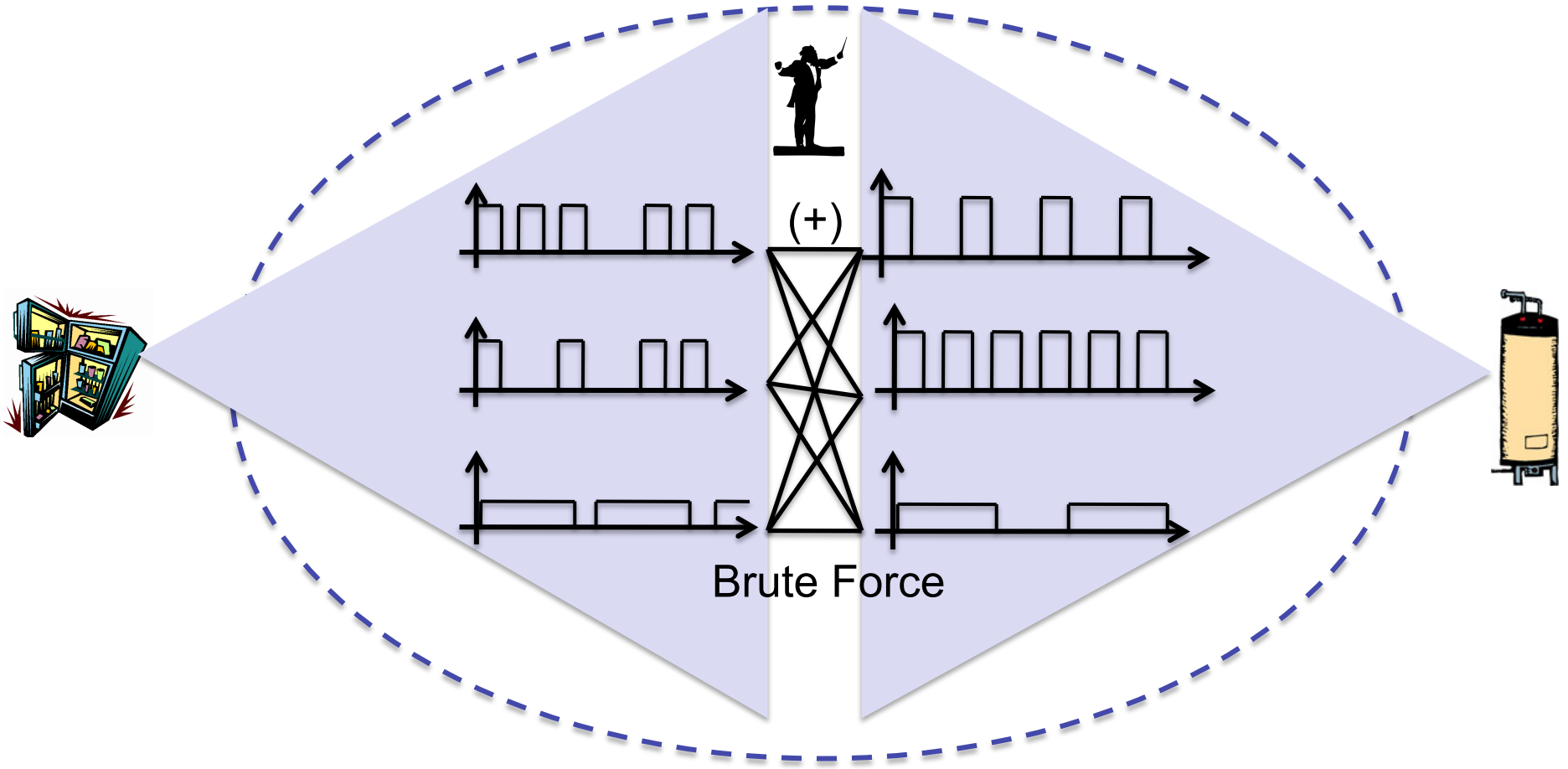
Central Coordination

- Gustavo Dudamel: A very young and talented conductor

Central Coordination (cont.)

- Although so young and talented he can end **overloaded**!

Central Coordination (cont.)

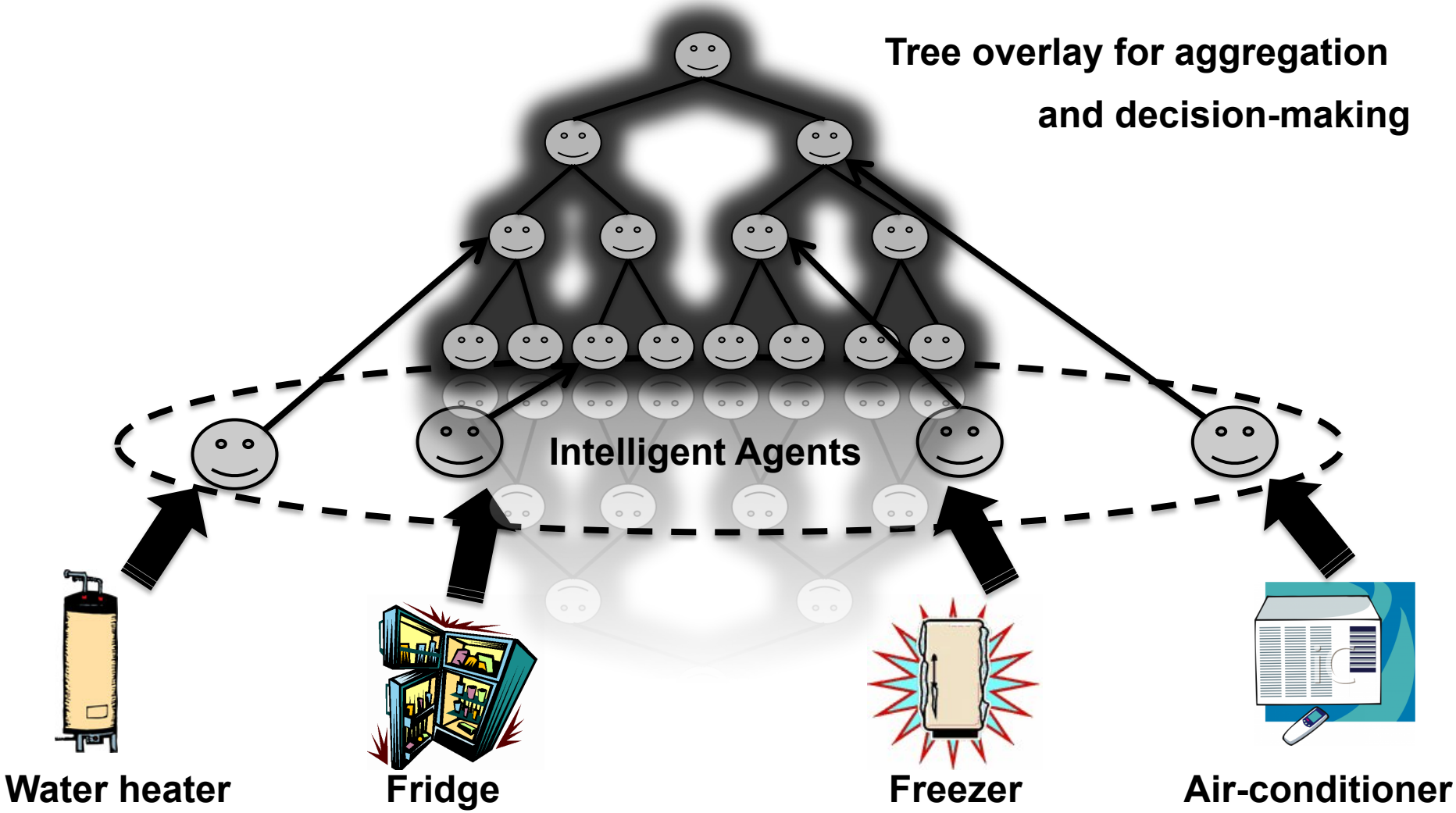


Complexity = # of possible plans$^{\#\ \text{of devices}}$

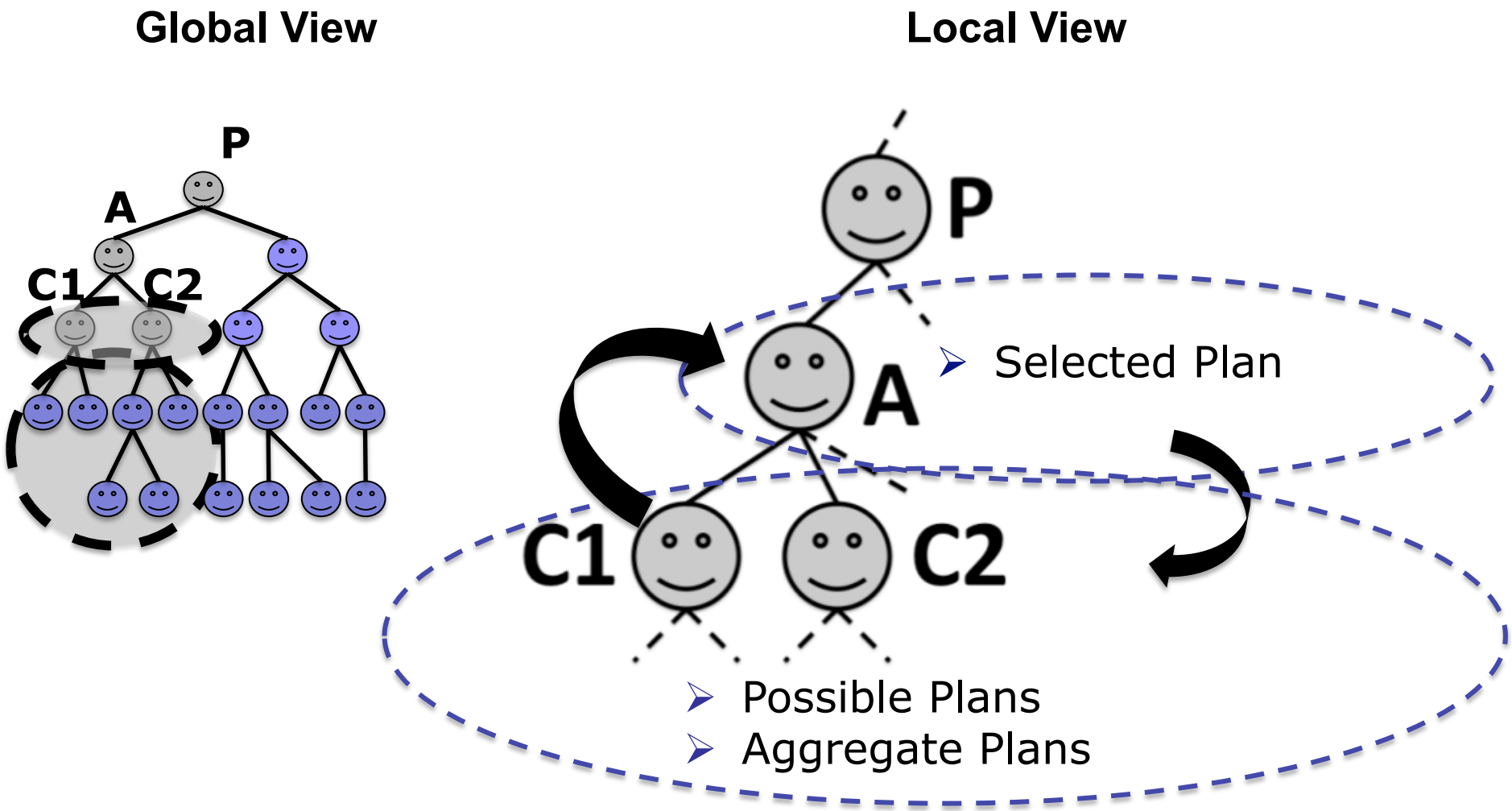
Central Coordination (cont.)

Guarantees the optimum stabilization **but unscalable!**

Distributed Coordination



Algorithm Overview



Simulations

3280 agents

3 different types of thermostatic devices

3 children per agent

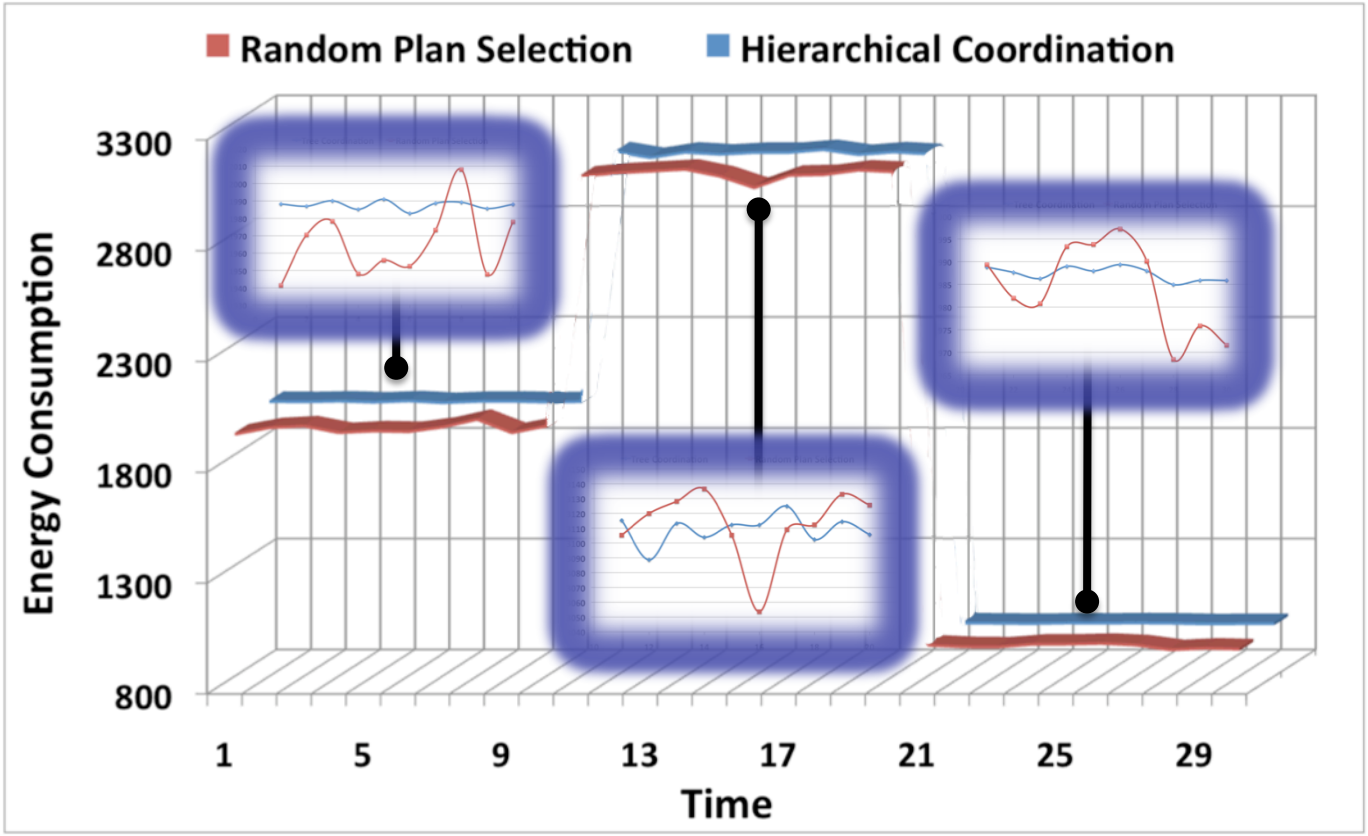
7 levels in a balanced tree

5 possible plans per agent

Investigation of **minimizing deviations** and **reversing deviations**

Comparison with the **random plan selection** (greedy agents)

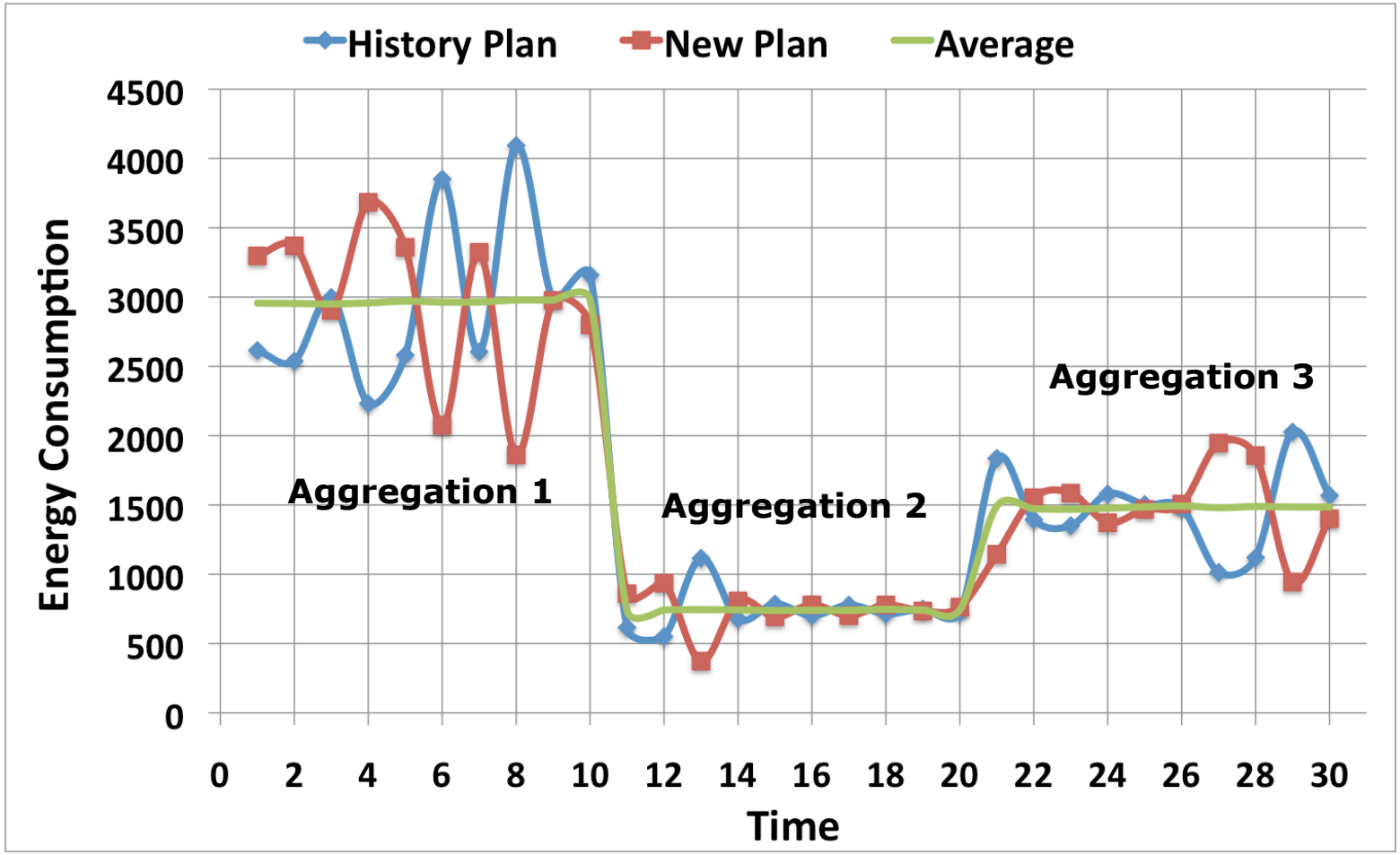
Minimizing Deviations



Aggregation 1 **Aggregation 2** **Aggregation 3**

63% Avg. Decrease in Oscillations

Reversing Deviations



Conclusions

- **Distributed hierarchical coordination** for self-stabilization
- **Software agents** with **local knowledge** and **local tasks**
- **2 fitness functions** for **adaptive decision making: minimizing** and **reversing** oscillations
- *Improvement in keeping oscillations minimum and reversing oscillations*

Future Work

Self-stabilization

simulations

from single to multiple machines, live deployment

applications

power management of data IBM data centers

robustness

application-independent self-organization service

Questions?