

# Towards Emergent Energy Synchronization using Agents

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**Dynamic Adaptive Systems Design, Evangelos Pournaras, May 2010**

# Motivation

Fireflies

Planetary systems

Pacemaker cells

**Synchronization is a key determinant in nature  
and energy power systems**

Frequency signals

Demand-side management

Energy generators

# **Demand-side management**

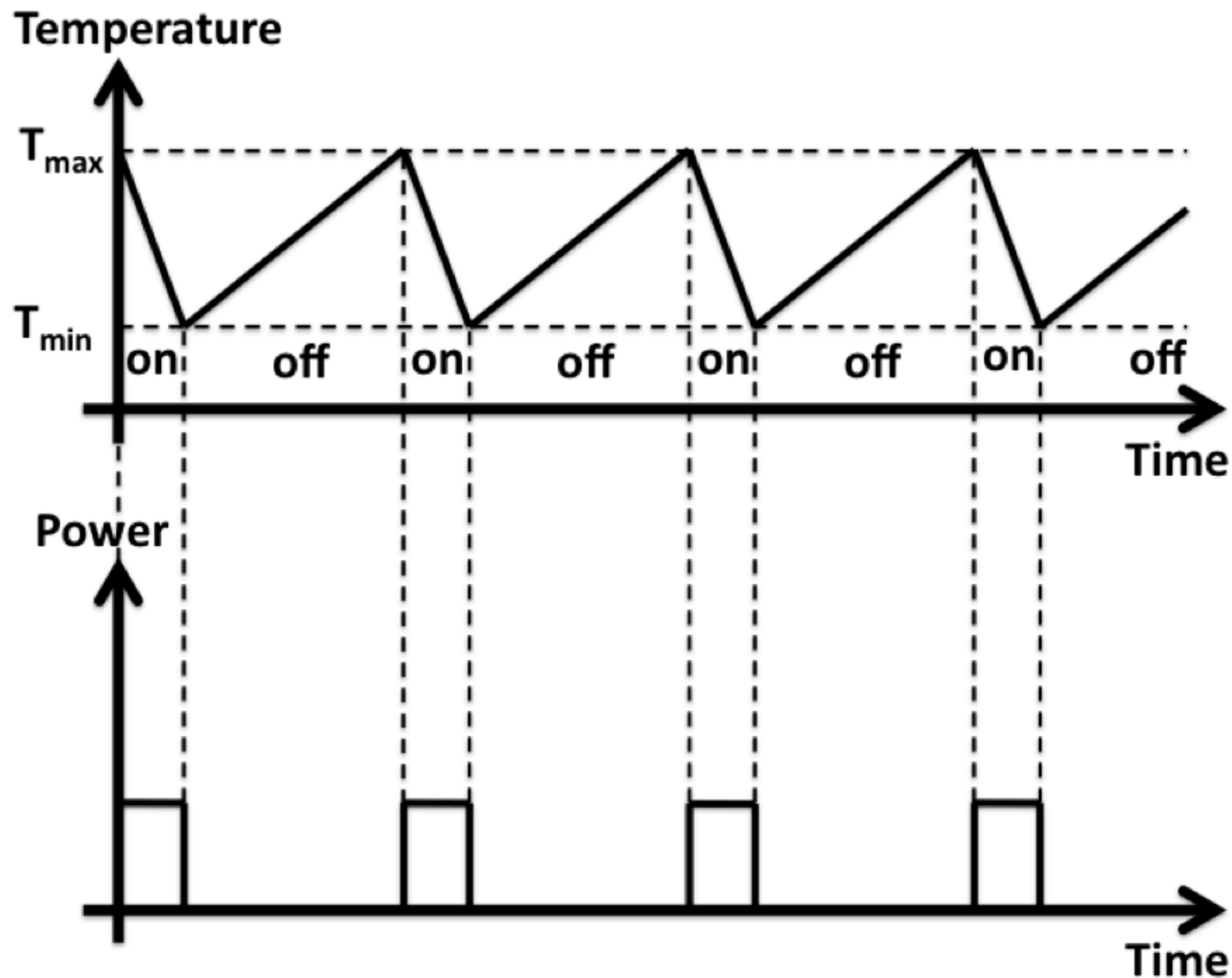
**Autonomous agents for controlling  
thermostatic devices**

**e.g. refrigerator, water heater,  
air-conditioning**

**Why:** High energy consumption  
( $\approx$  25% of total consumption in the USA)

**Goal:** Agent-based stabilization of energy  
consumption in a set of interconnected devices

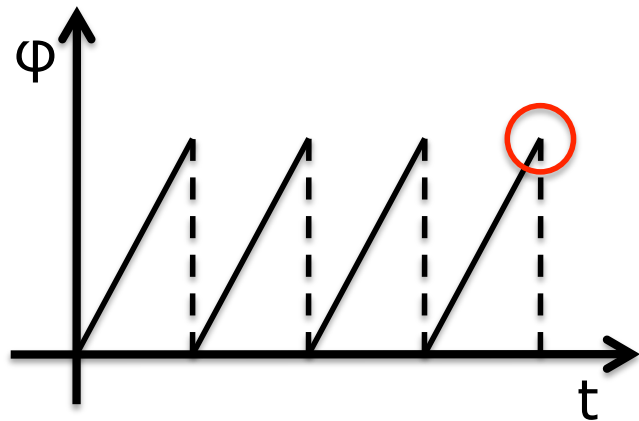
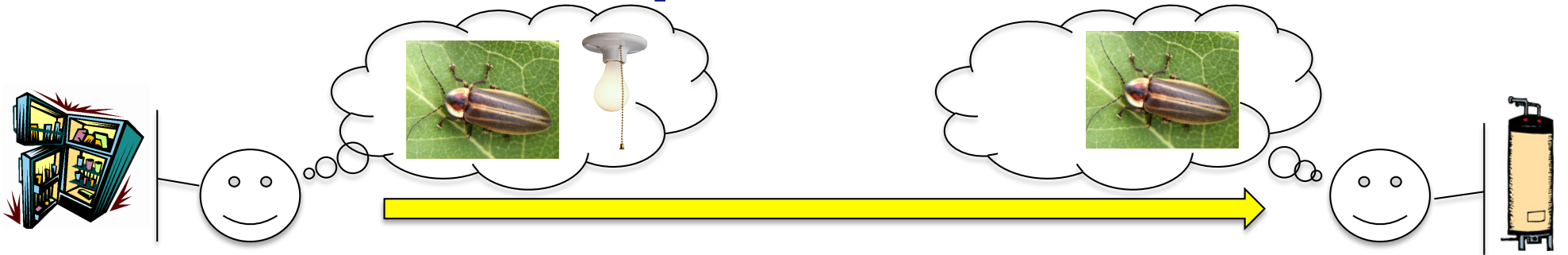
# Demand-side management



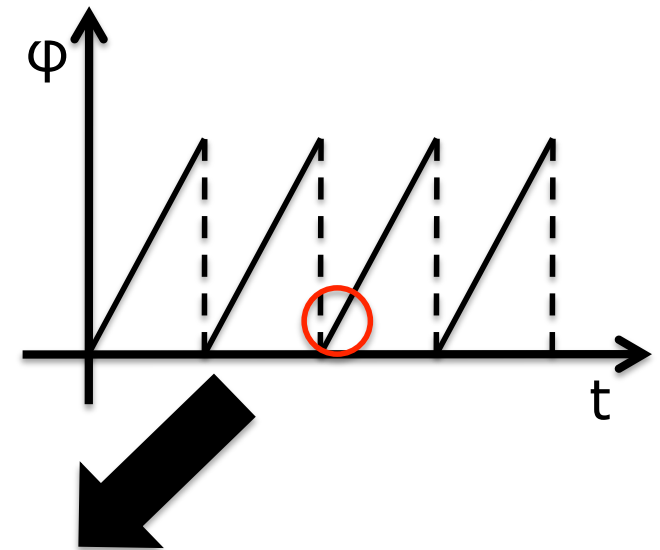
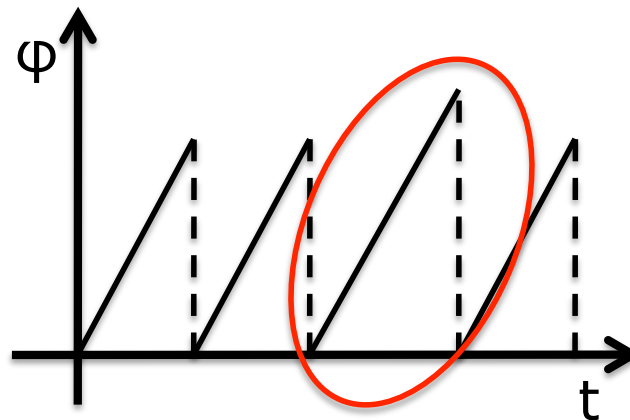
# **Approach for stabilization**

**Energy (de) synchronization of agents**

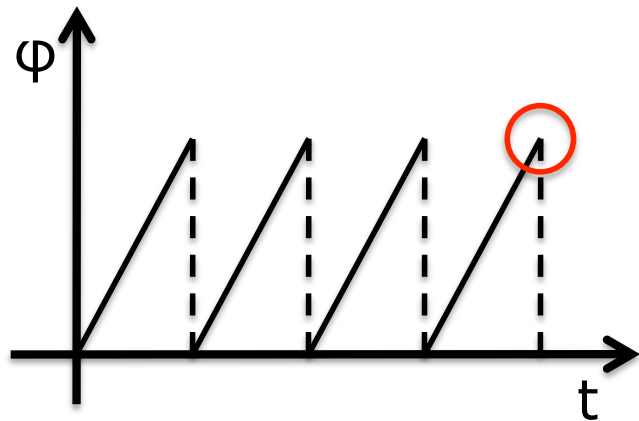
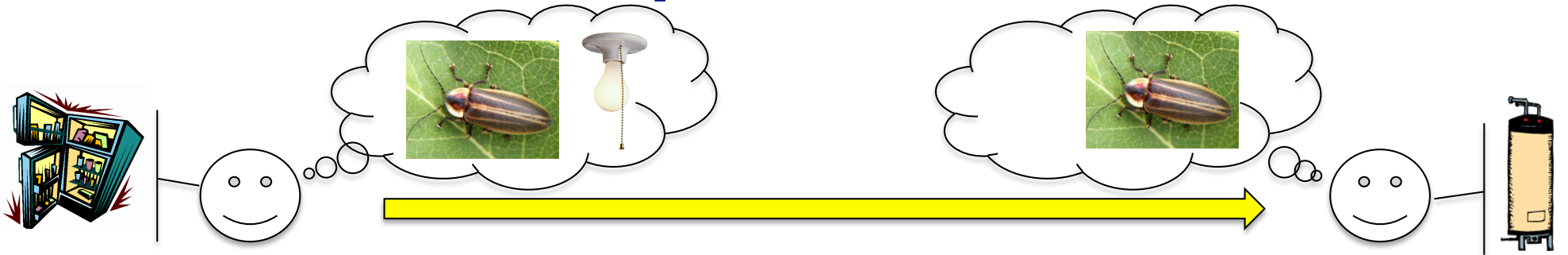
# The model of coupled oscillators



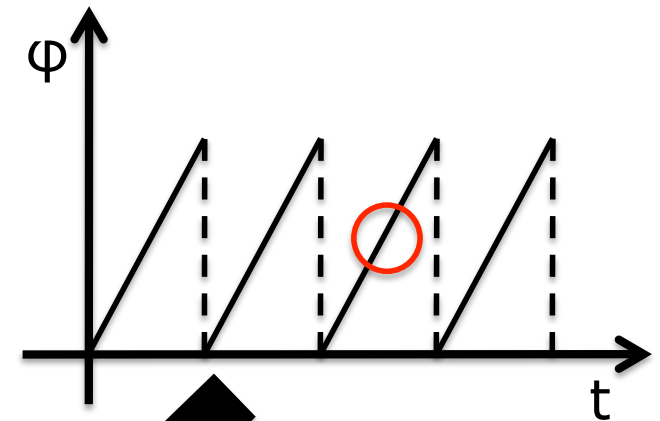
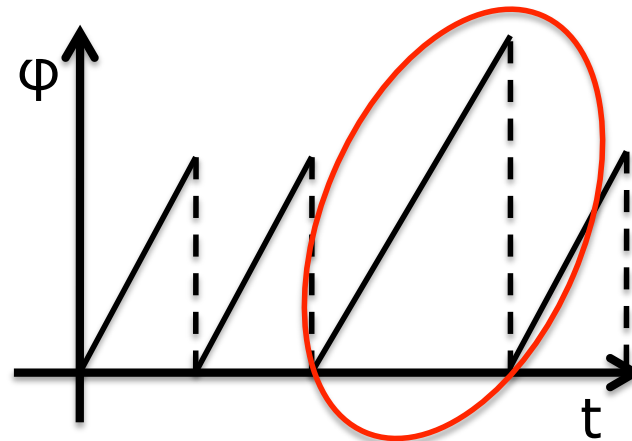
Phase adaptations  
to coordinate



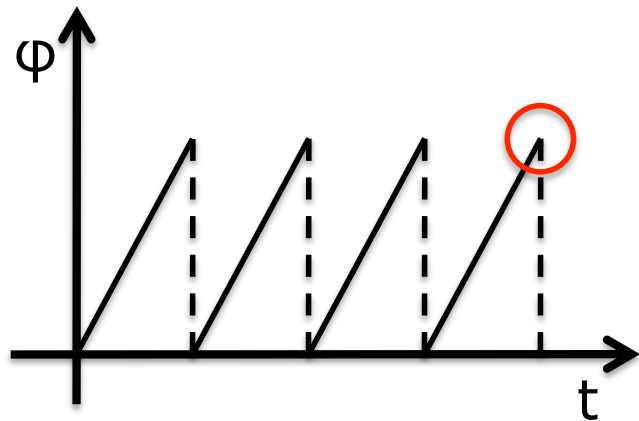
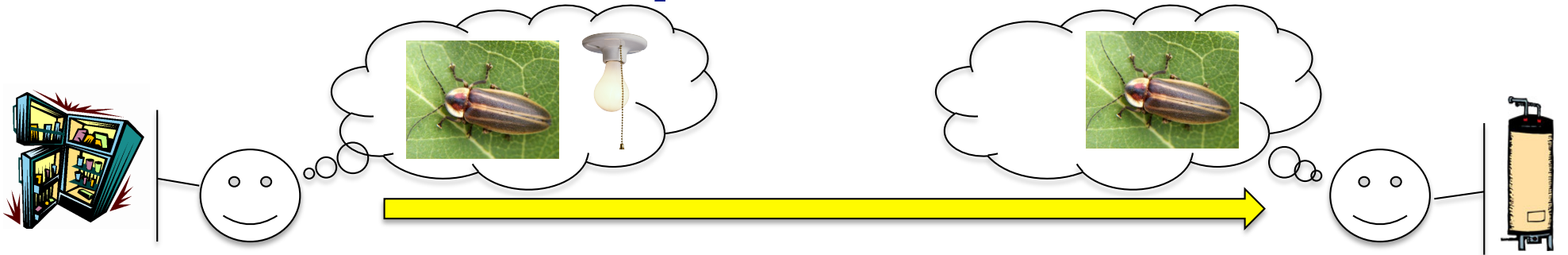
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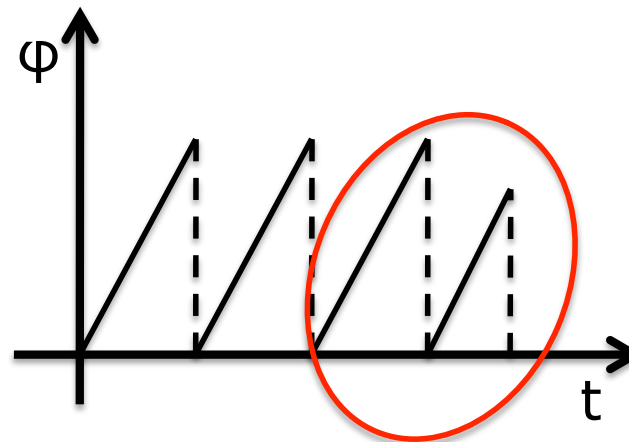
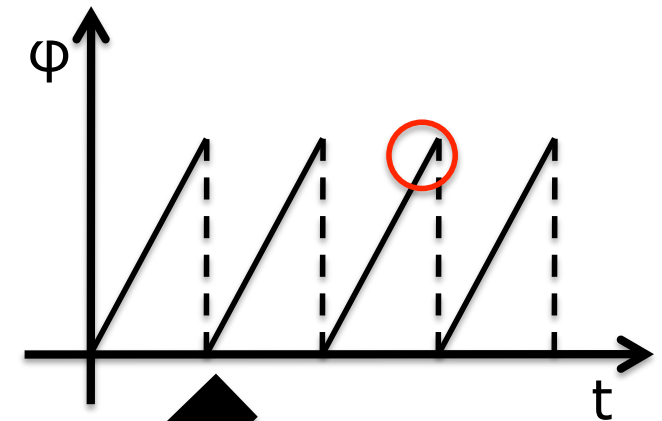
Phase adaptations  
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# The model of coupled oscillators

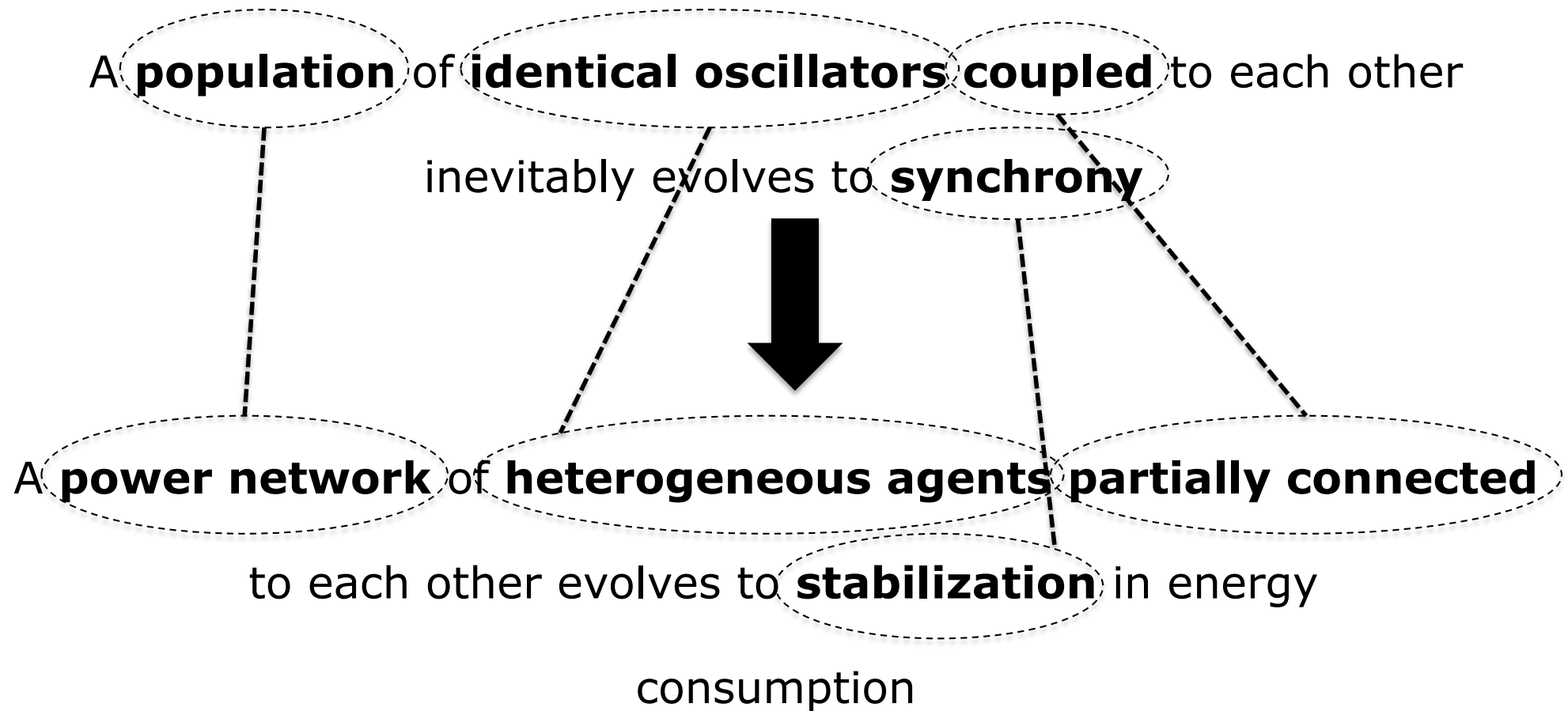


Phase adaptations  
to coordinate





## The model of coupled oscillators (cont.)



# Conclusions

- Synchronization: a key determinant in nature and energy systems
- A major demand-side consumption is experienced in a periodic fashion

**Demand-side management can emerge from agent-based (de) synchronization mechanisms**

- Many interesting challenges in this approach

**Please now synchronize your  
clapping**

**Questions?**

