



National Technical University of Athens
Nice December 2008

Smart Agent Technology to Help DER Integrate Markets: Experiments in Greece

The Third International Conference on Integration of
Renewable and DER

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Outline

This work presents the experience of ICCS/NTUA in MAS control

Introduction- MAS

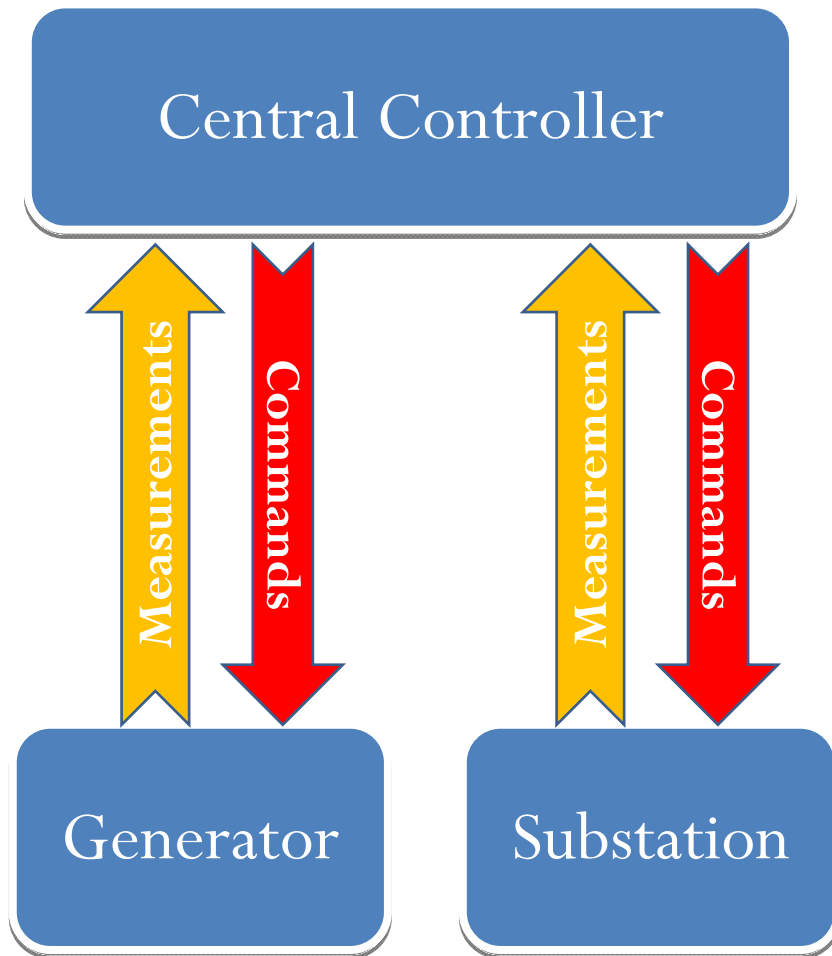
General Concepts

The work in More-Microgrids and EU-Deep Projects

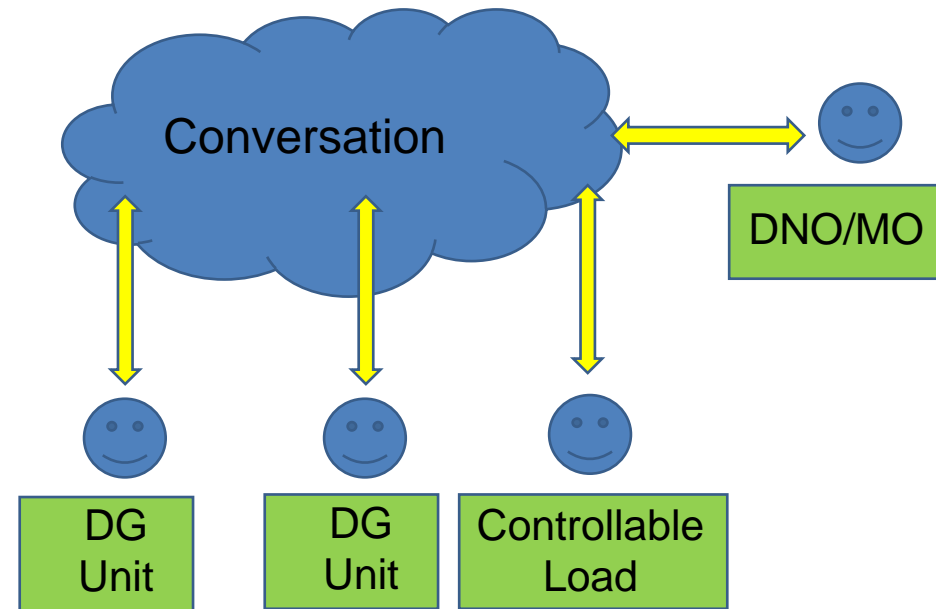
Field Test

Control Approaches

Traditional Control Concept

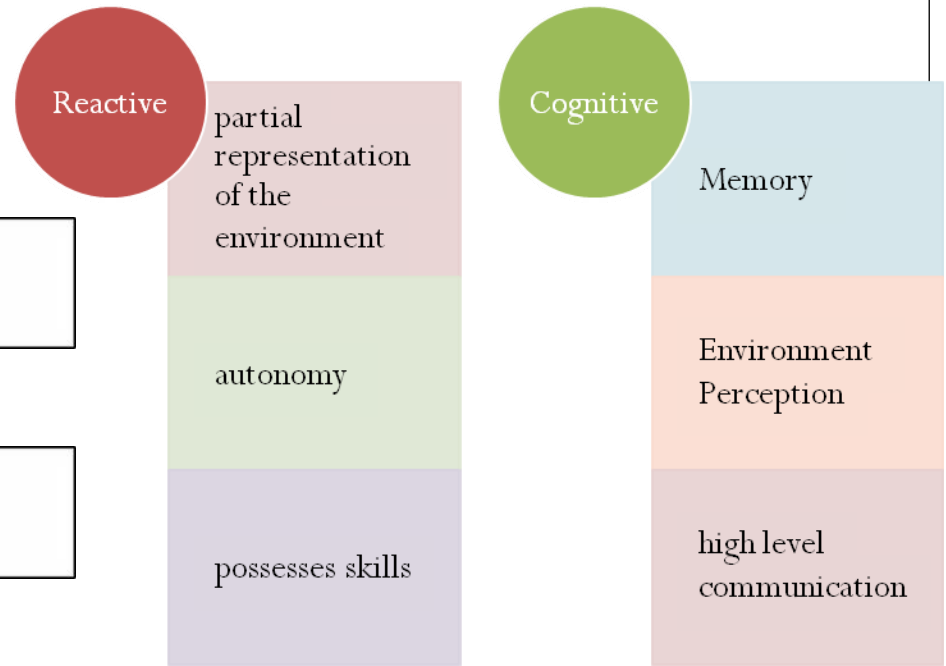


Agent Based Concept



The Agent

- Physical entity that acts in the environment or a virtual one
- Partial representation of the environment
- Agents communicate – cooperate with each other
- Agents have a certain level of autonomy
- The agents have behaviour, objectives, resources and skills



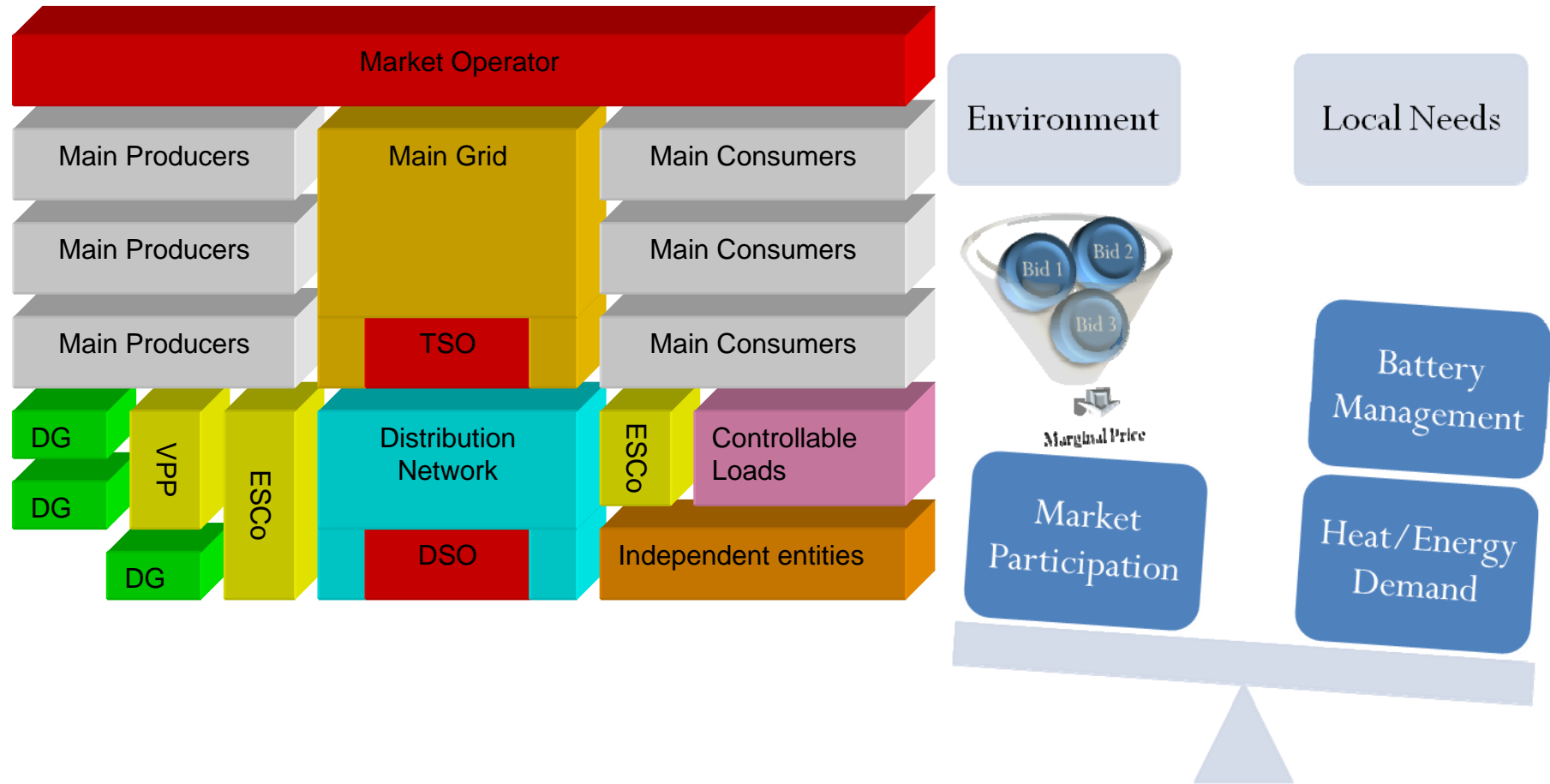
The characteristics of the MAS depend on the application



MORE MICROGRIDS

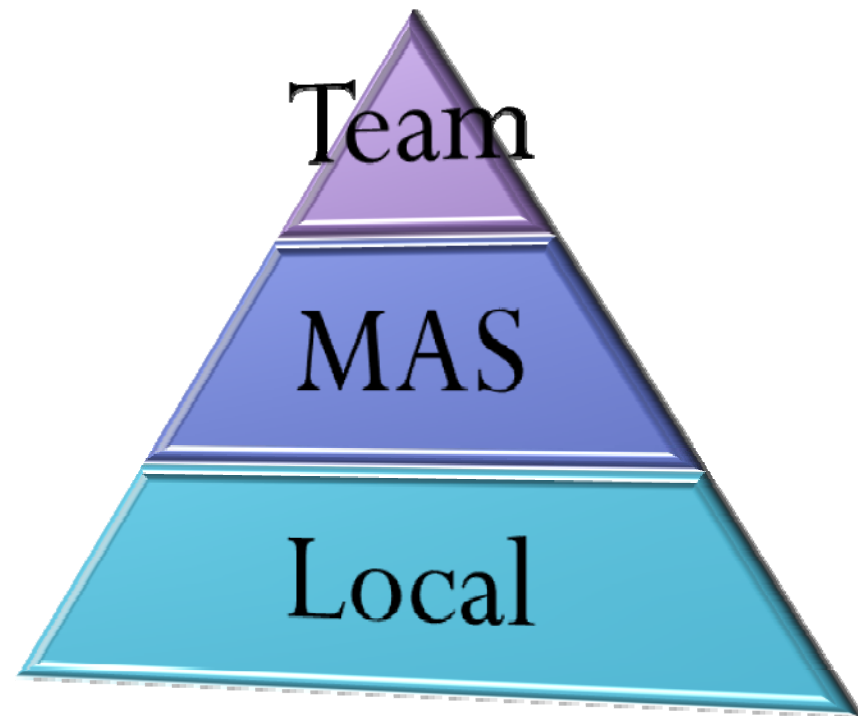
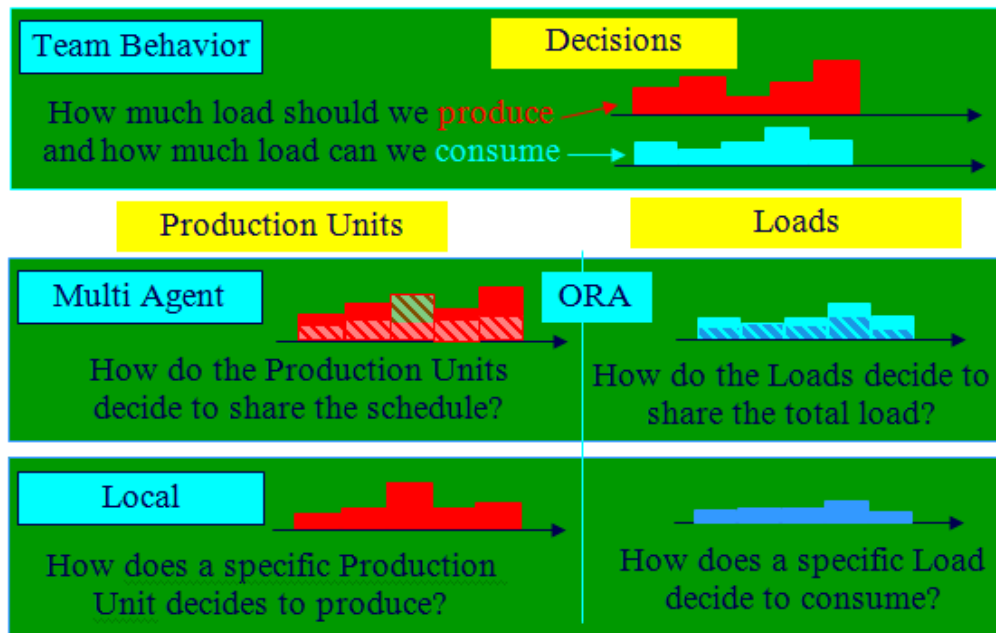
- Development of algorithms and architecture for agent based control
- Development of software for an intelligent load controller. The hardware was developed by ANCO S.A.
- In cooperation with SMA, ISET and CRES the load controllers were installed in Kythnos test site

Market Participation

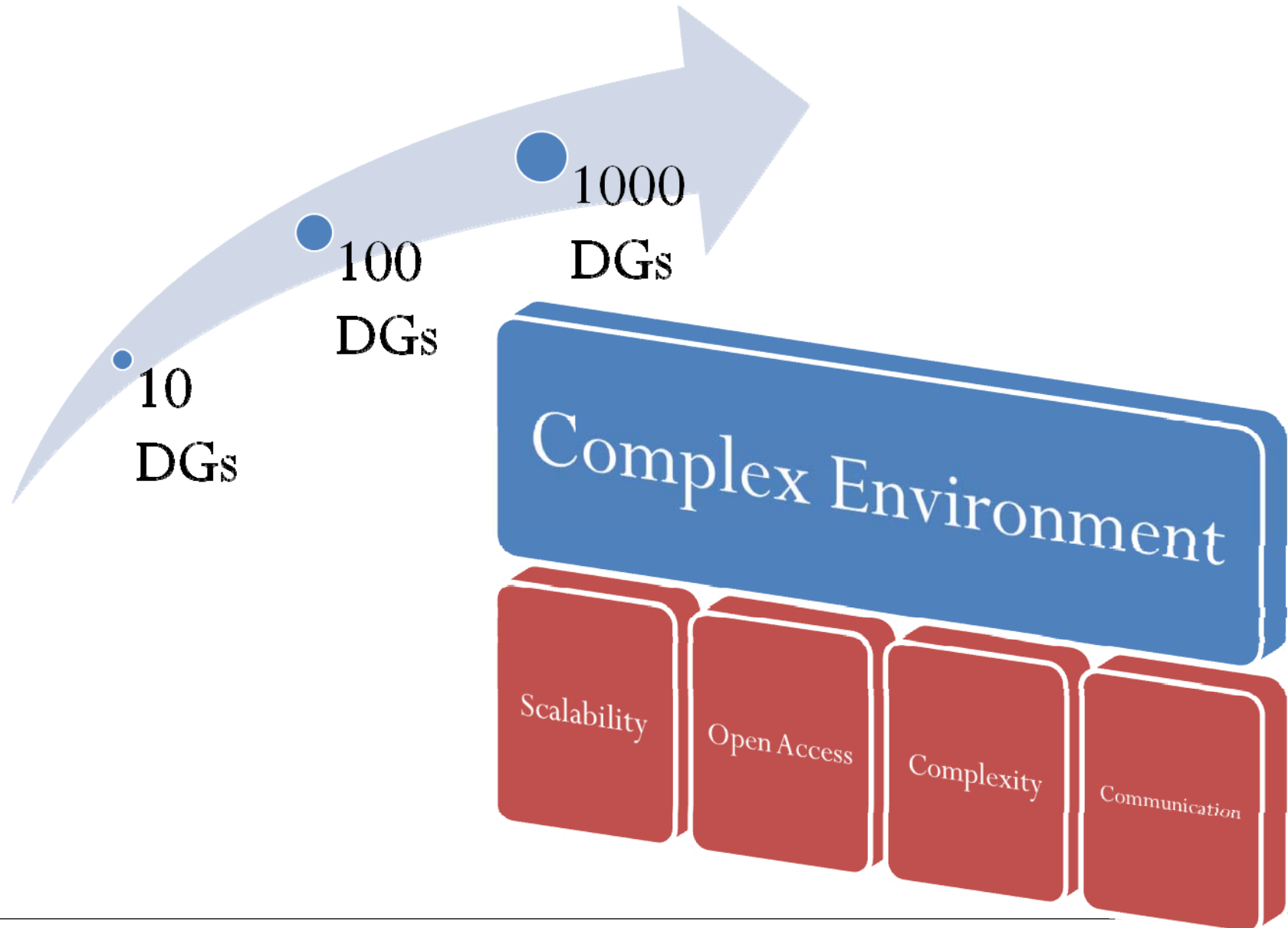


MAS Organization

One difficult part is to organize all the operation of the system: market participation, ancillary services, local unit management, etc



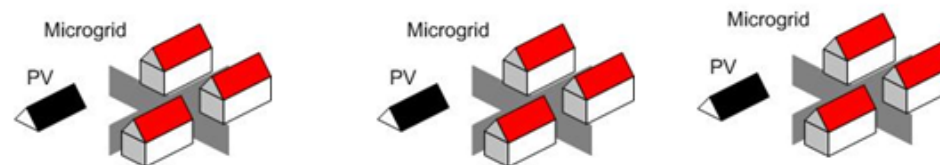
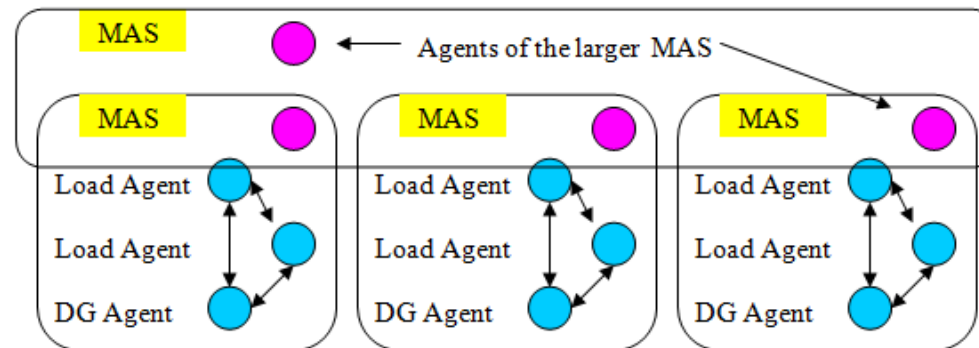
Complex Environment



The main Multi Agent System is formed by a number of smaller MASs



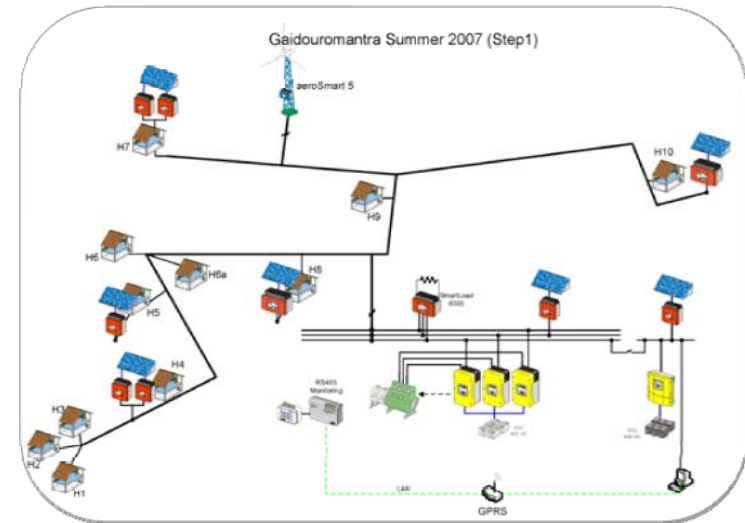
Case 1 Single Microgrid



Case 2 Multiple Microgrids

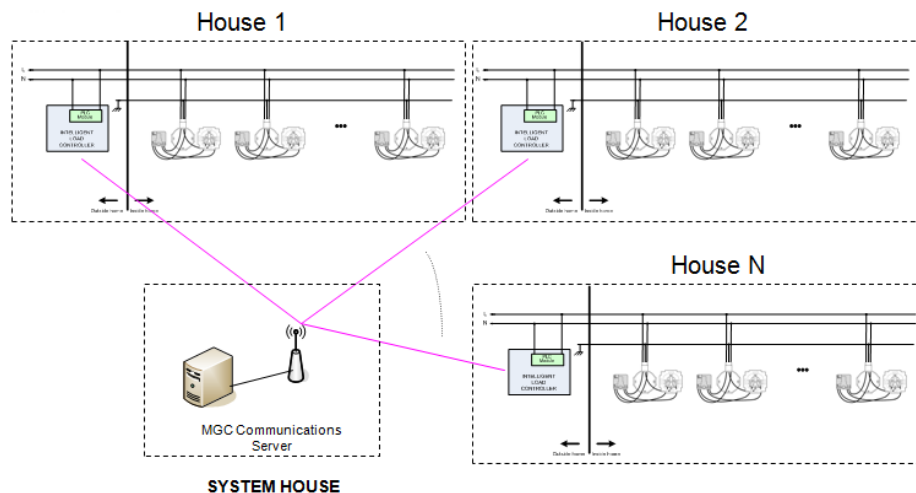
Multi Agent System Installation in Kythnos Island

Intelligent Load Controllers (ANCO) are installed in 5 houses trying to optimize the usage of available energy



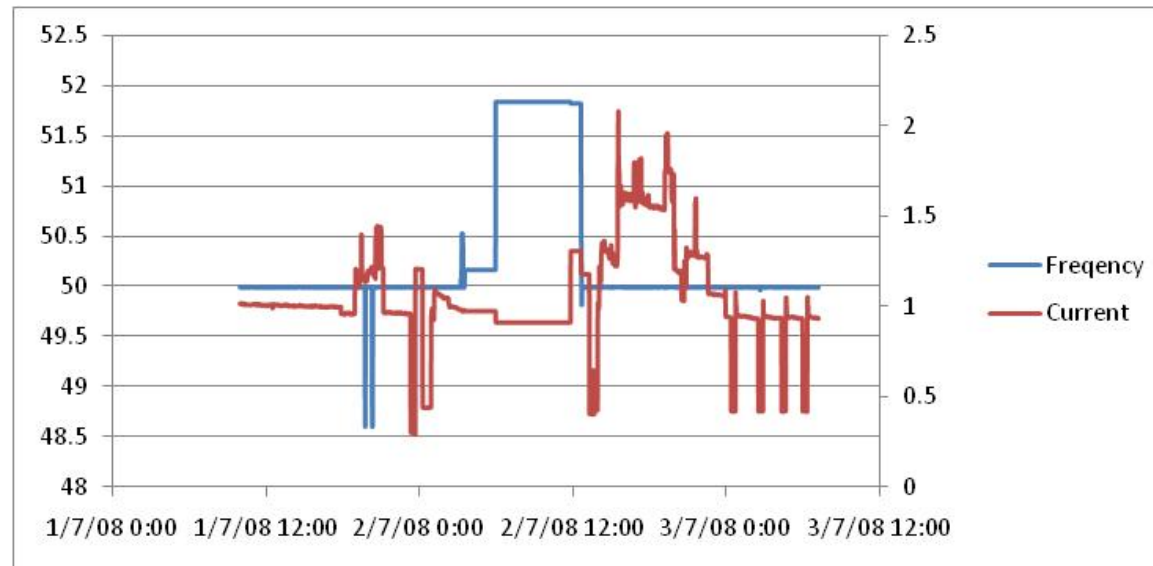
The Intelligent Load Controller

1. Windows CE 5.0
2. Intel® Xscale™ PXA255
3. Java VM/Jade LEAP
4. Electric measurements
5. Control of switches via PLC
6. WiFi/LAN



The MAS in Kythnos

- The agents are required to cooperate so that they make efficient use of the power supplied from the PV units and the batteries.
- The system minimizes the usage of the water pumps according to the available energy





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The EU-Deep MAS Experiments



Within the EU-Deep Experiments we tested:

- The MAS operation in a (virtual) energy market
- Creation of a VPP
- Advanced algorithms developed in More - Microgrids (Reinforcement learning)
- The advance architectures of multiple MAS





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The clients participated in the Scenarios are:

NTUA Test Site



Heat Pump(20kW)
PV (22kWp)

CHP (80kWel),
Loads, PV
(1kWp) Battery
Unit (5kW)

CRES Site



Meltemi Holiday camp

Loads (>3kW)





Scenarios

- **Scenario 1:** All of consumption is non-flexible. Test how production units adjust their output in order to participate in the market in a coordinated way
- **Scenario 2:** All of generation is non-flexible. Test how controllable loads adjust their consumption in order to follow the production limits
- **Scenario 3:** The whole system participates in the market as a single entity trying to maximize its overall gain. Generation and consumption are controllable.
- **Scenario 4:** Meltemi, CRES and NTUA participate in the market as three entities (MASs) that may cooperate or not. Test how a large number of agents can be organized and communicate in a harmonic way.



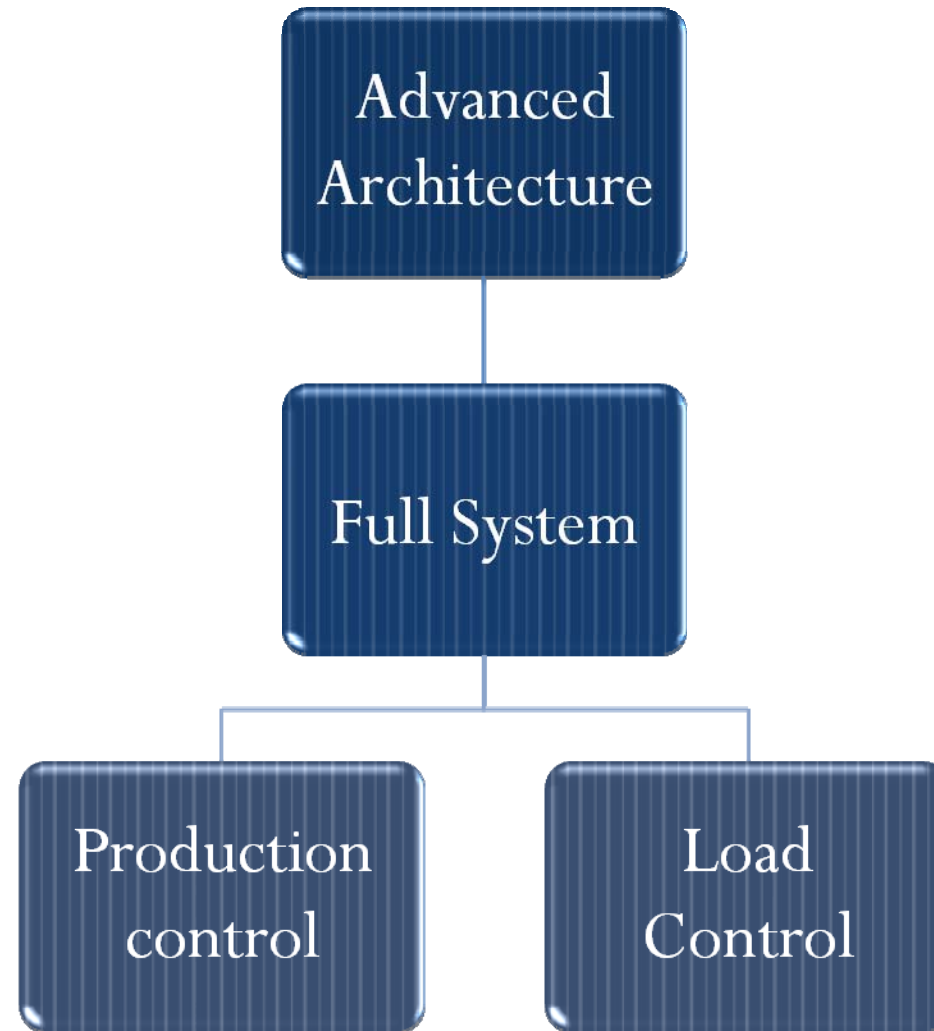


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Structure of the scenarios





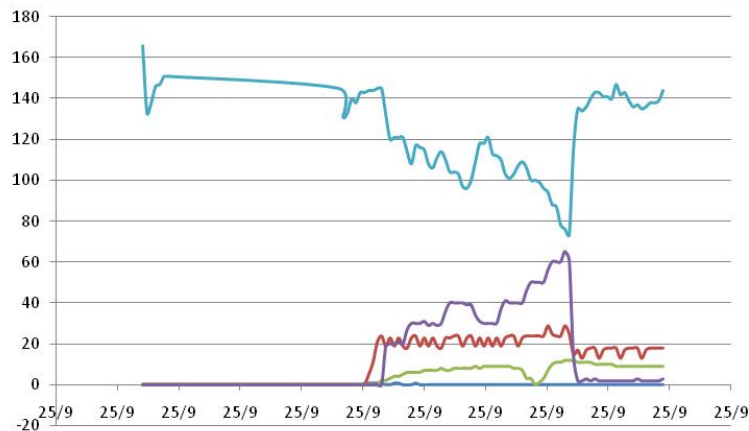
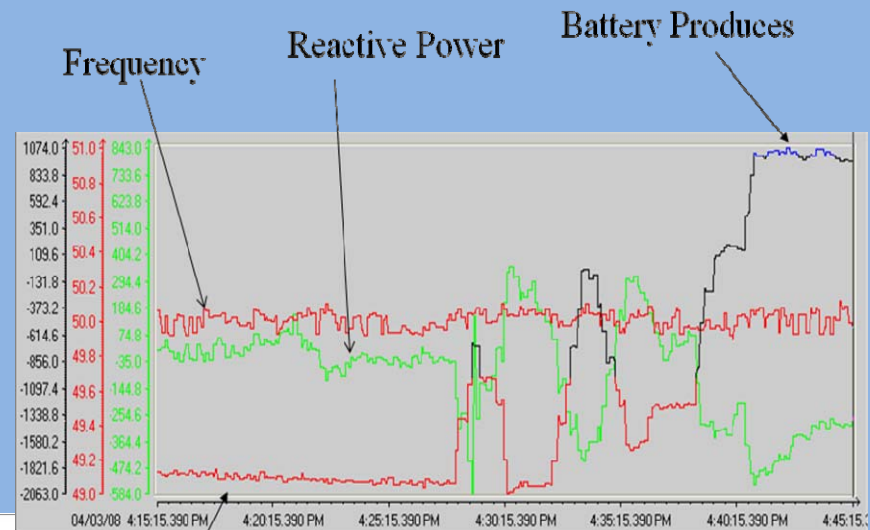
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Control of Production Units



Battery control



Battery Stores

CHP control

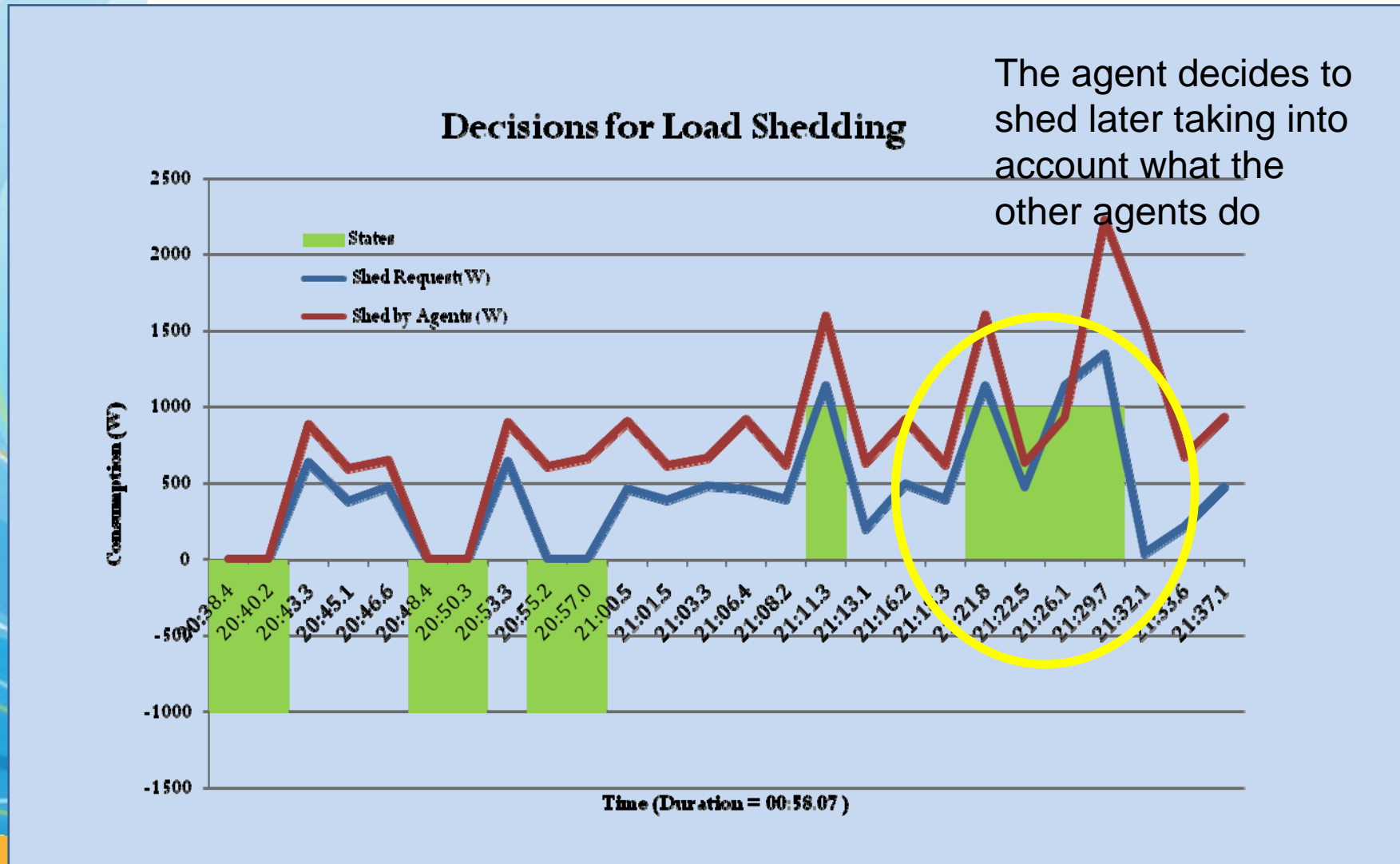




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The agents are trying to participate in the market
using machine learning techniques





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Offline simulations

- The MAS provides extra local information into the system
- Objective is to validate the added value of the local information



Thank you!!!!

