DISTRIBUTED INTELLIGENT SYSTEMS
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Market-based vs. Threshold-based Algorithms in Sensor and Actuator Networks

Comparison for energy distribution

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Market-based vs. Threshold-based Algorithms in Sensor and Actuator Networks

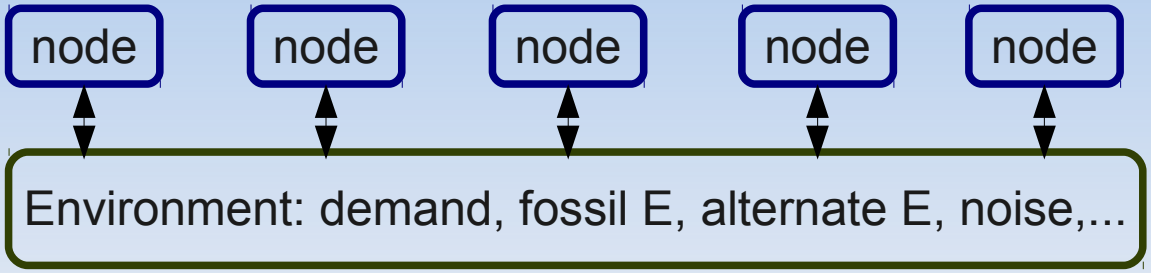
- Plan of presentation
  - Introduction
  - Model
    - Global idea
    - Threshold-based approach
    - Market-based approach
  - Results
    - Global efficiency comparison
    - Zoom into the behaviours
    - Noise sensibility
    - Threshold parameters analysis
    - Comparison of communication and computational costs
  - Conclusion and future works

Introduction: ernergy distribution as a task allocation problem

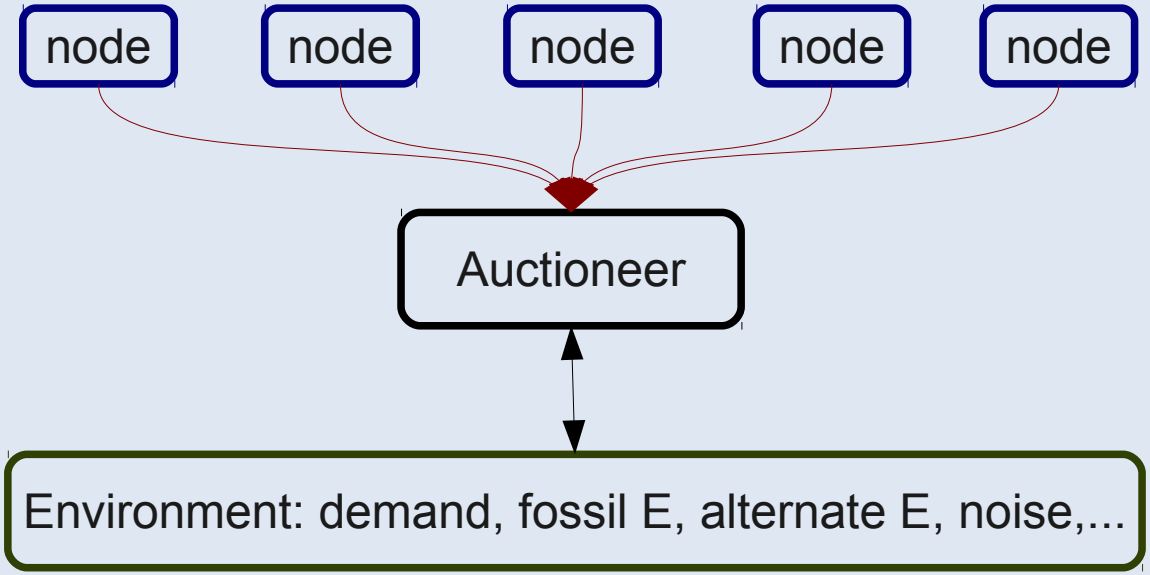
- Whats?
  - Alternative energy sources?
  - A problematic of varying scales: from tiny sensors/actuators networks to continental energy distribution
- Why nots?
  - Why not simply store energy?
  - Why distributed?
- Task Allocation?
  - Localization
  - Task Assessment
  - Performance analysis

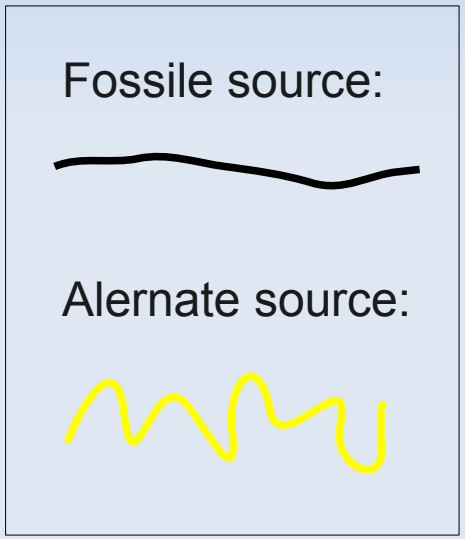
The model

Threshold: a fully distributed system



Market: a fully centralized system

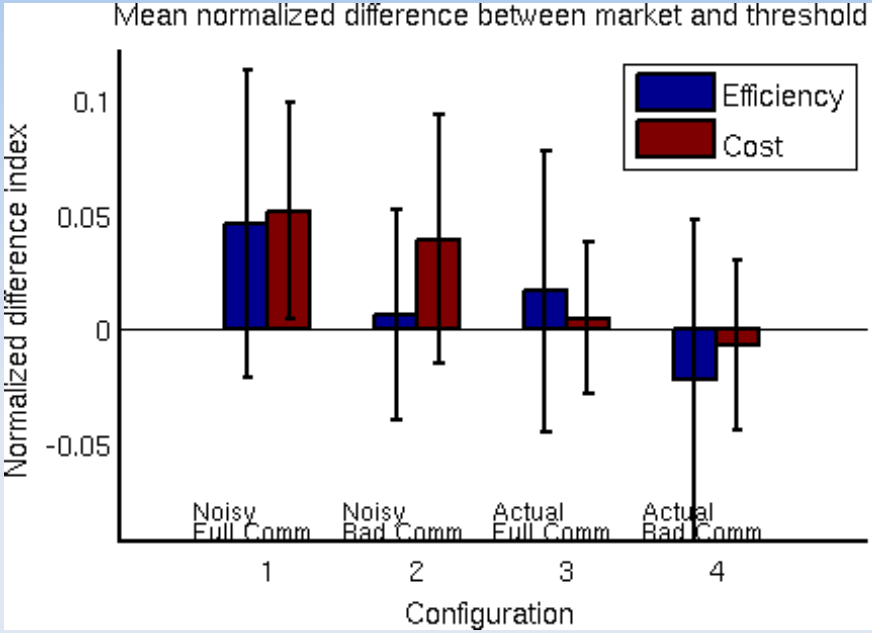


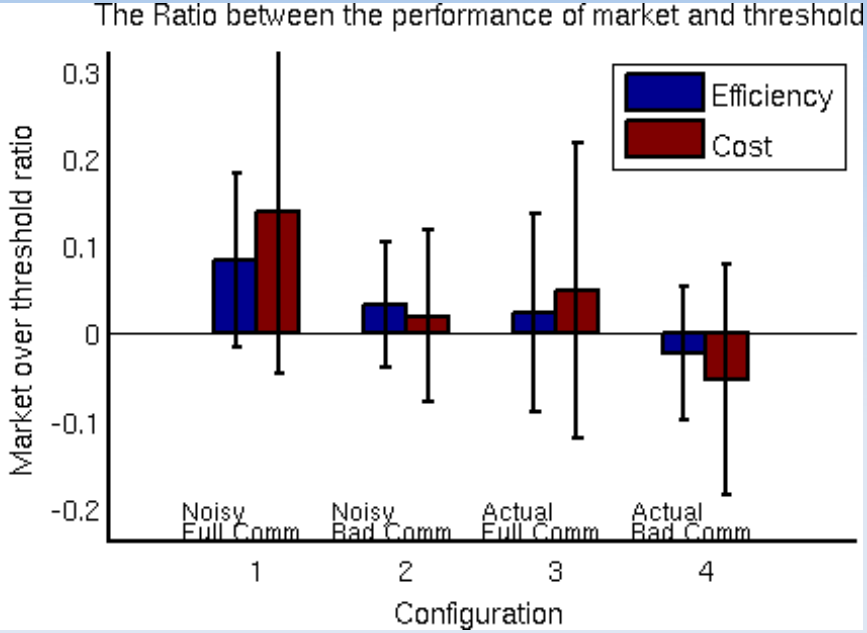


The setting

- Environmental parameters
  - Modelling alternate energy: rapid variations
  - Modelling fossile energy: very slow variations
  - Modelling noise
- Threshold based
  - Non-linearity
  - Adaptiveness
- Market based
  - Works out of the box !

Results – Global efficiency and cost comparison

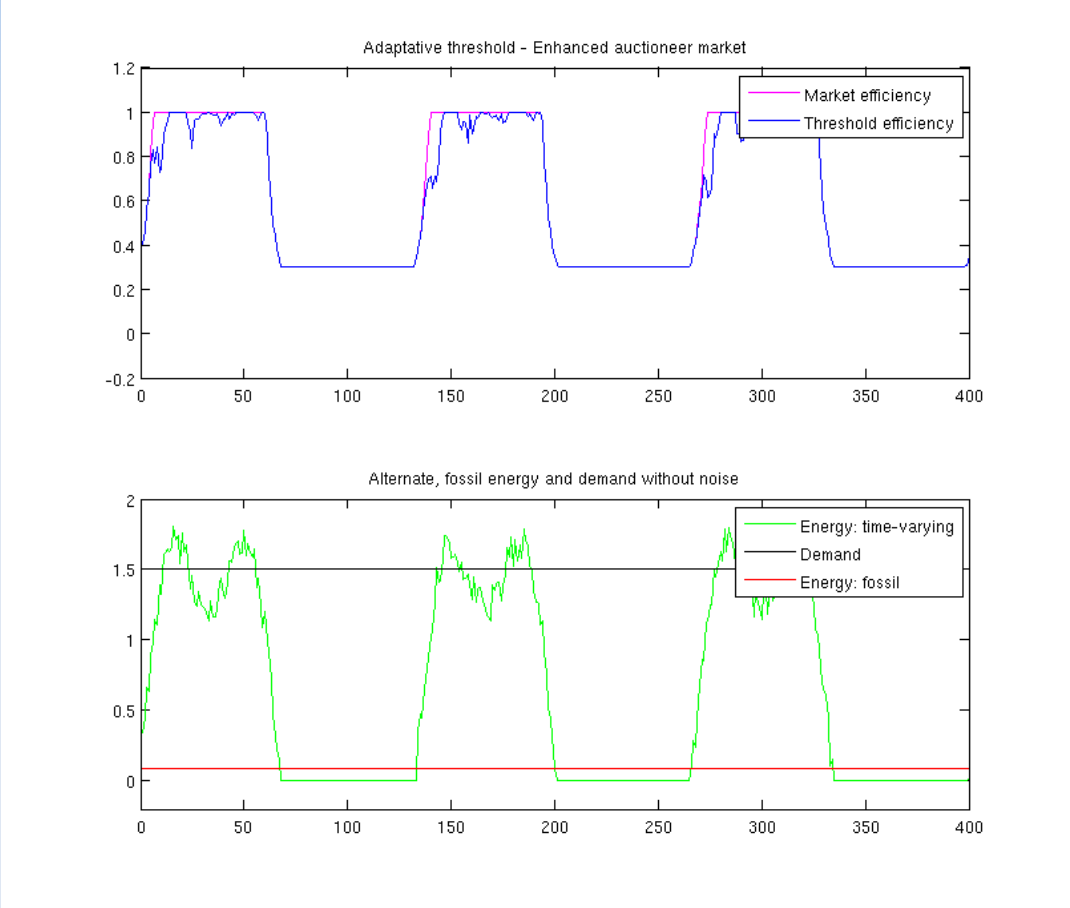




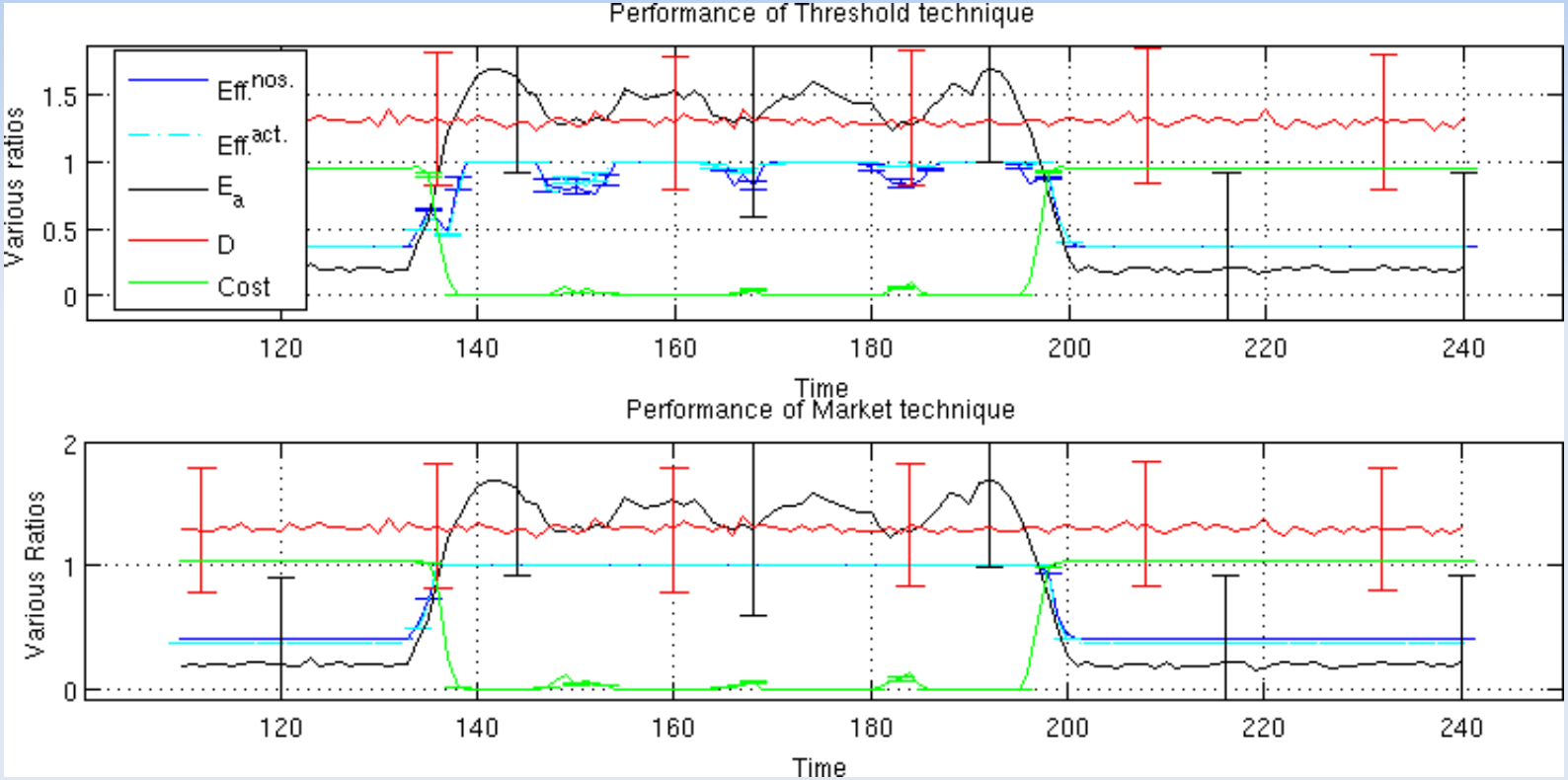
- Why two plots?
- Higher efficiency, higher cost.

Results - Zoom into behaviour of methods (1)

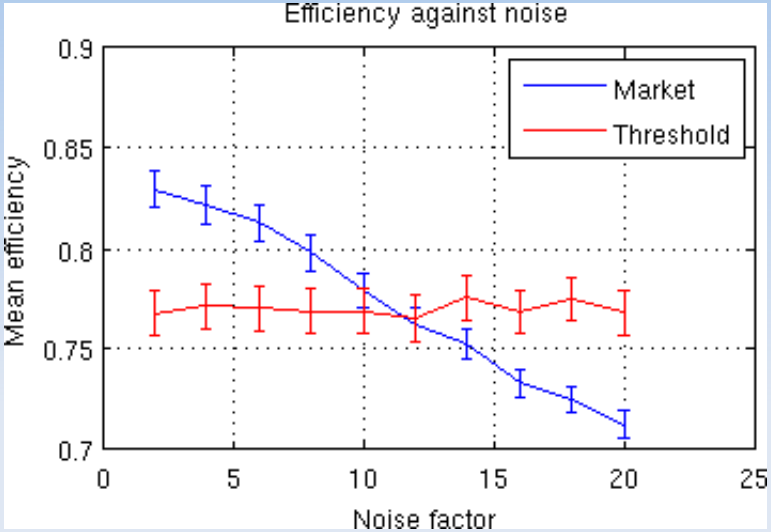
- Threshold shows sligthly lower performance
- Positive effect of adaptative mechanism
- The shape of the alternate source function influences the amplitude of the differences in performance

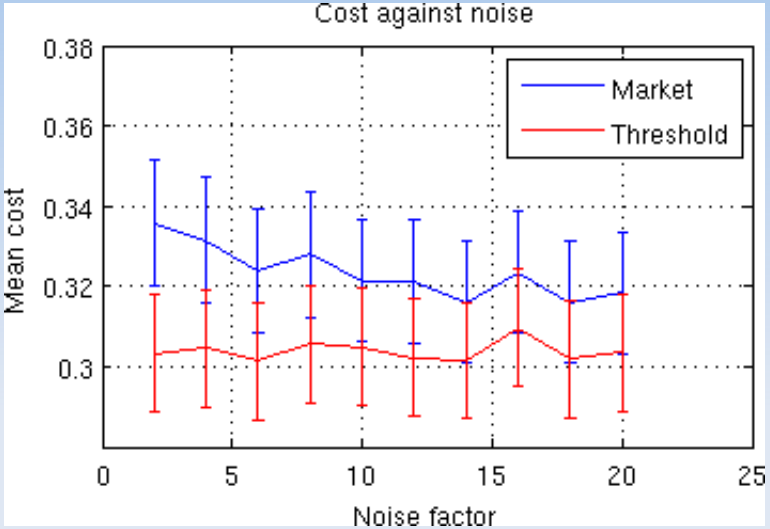


Results - Zoom into behaviour of methods (2)



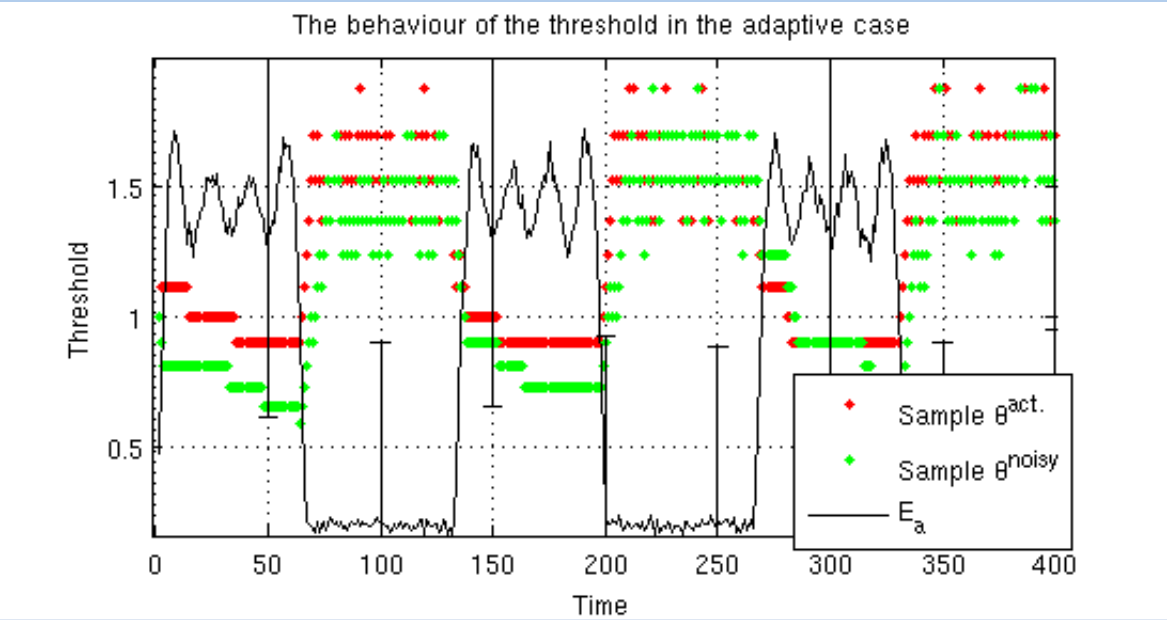
Results - Noise sensibility





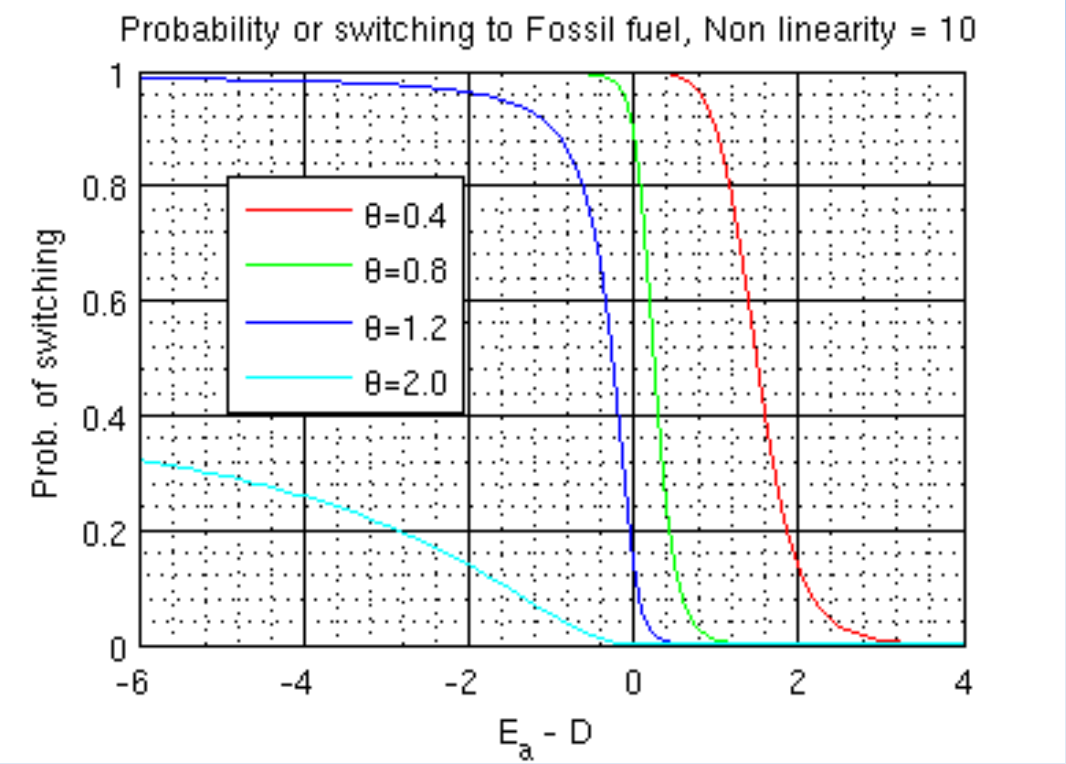
- For low noise levels, market performs better
- Threshold doesn't seem to be influenced by noise
- Relation cost – noise
  - For threshold, no clear trend
  - For market, slight decrease

Results - Threshold parameters analysis (1)



- Good adaptation of threshold in response to the stimulus
- Impossible with fixed threshold

Results - Threshold parameters analysis (2)



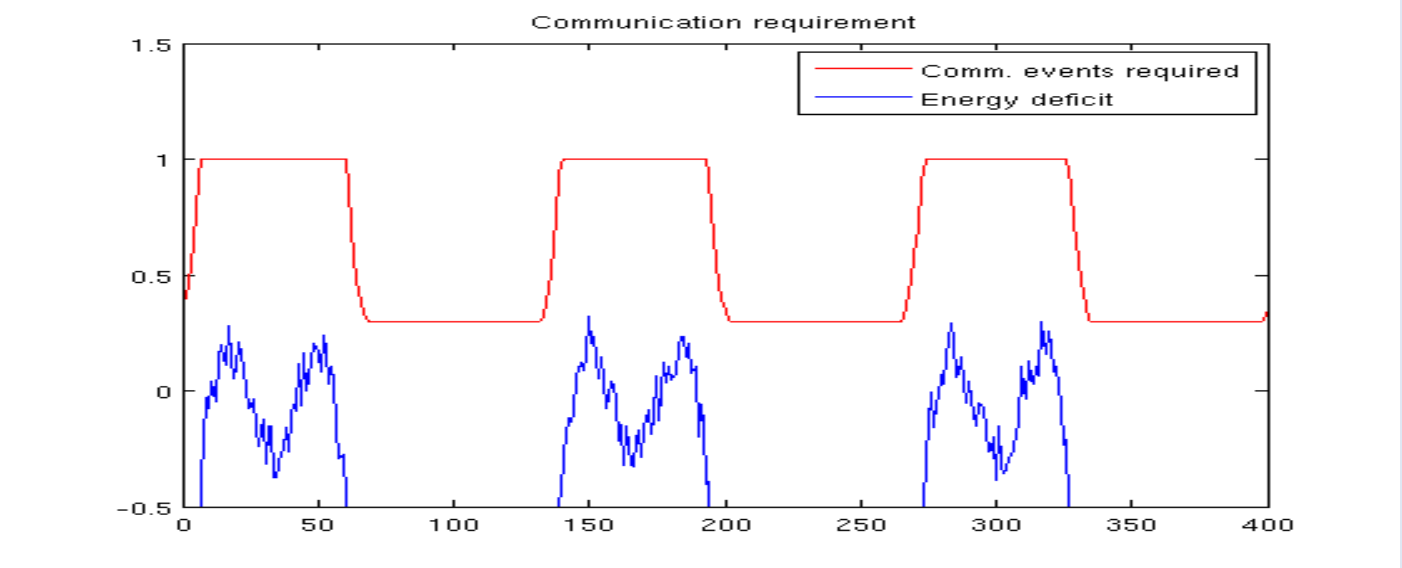
- Pre-emptive behaviour

Results – Market auctioneer

- 2 models:
  - Higher bidder: the ”wall-street” model
    - Intuitive way to attribute energy: the more a node needs energy to more it will get
    - Limitation: if one node needs a lot, it might avoid a whole set of low bidding node to meet their demand, conducting to lower efficiency
  - Lower bidder: the efficient model
    - By providing energy to the lowest bidders, fossile source can be divided into more pieces
  - This is only valid as long as we consider a system where we want to minimize the number of nodes meeting the demand at each time step

Results - Comparison of communication and computational costs

- Dependence towards communication is the crucial limitation of the market-based approach
- This relation is difficult to investigate without testing on real hardware
- However, the existence of an amplifying stress loop on the system is obvious: them more energy is needed, the more communication is needed, which consumes energy, etc...



An alternative: towards a mixed model ?

- Each method has got different advantages / drawbacks under different environmental conditions:
  - If knowledge of communication quality/efficiency is available, one could mix the to method:
    - Market when good communication is available and perception not too noisy
    - Then switch to threshold as soon as thoses to parameters get worse
  - Such a combination might lead to substantial improvments in global performance

Conclusion and future works

- Current code: has been constructed in such a way that improving the complexity of the model for further investigation is possible
- SensorScope data could be use to test the algorithms on more realistics model
- Scalability
- Other application example: watershed unit hydrogramm smoothing in urbanized areas – flood managment ?
- Possible improvments of the threshold:
  - Multi-objective optimization: NSGA?