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A Framework for Decentralized Energy Trading in Power Systems

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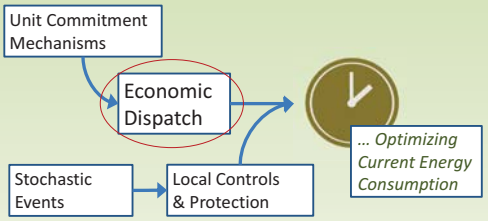
Objectives

Needs for the future

- Better utilization of existing distribution networks
- Efficient management of flexible demand
- Efficient management of distributed generation and storage

Our approach

- A extended look into the economic dispatch problem
- A close to real-time fine-grained decentralized solution



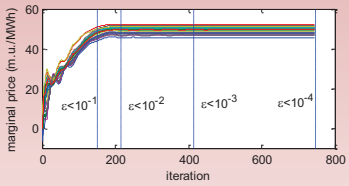
Distributed Optimization

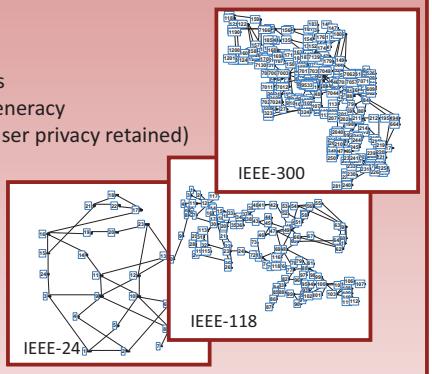
Proximal Based Decomposition

- Mathematically proven approaches
- Easy to apply

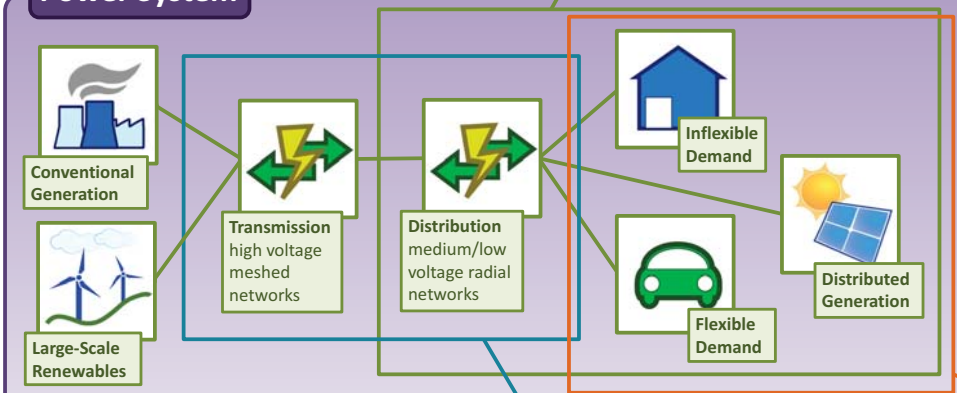
What does it do?

- Converges to optimal marginal prices
- Can handle non-convex cases & degeneracy
- Limited amount of info exchanged (user privacy retained)
- Can work fully decentralized





Power System



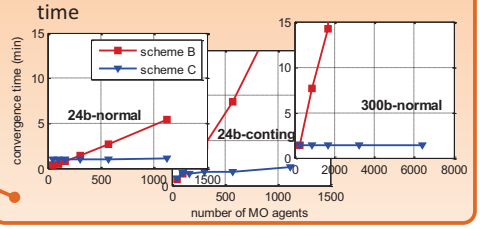
User Disaggregation

Our tests

- Different decomposition schemes
- Various proximal decomposition algorithms

Do we need aggregation?

- At the right points can improve convergence time



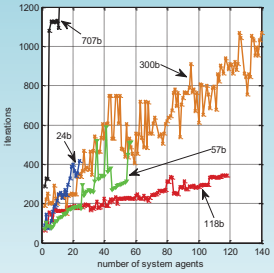
Network Decomposition

Our tests

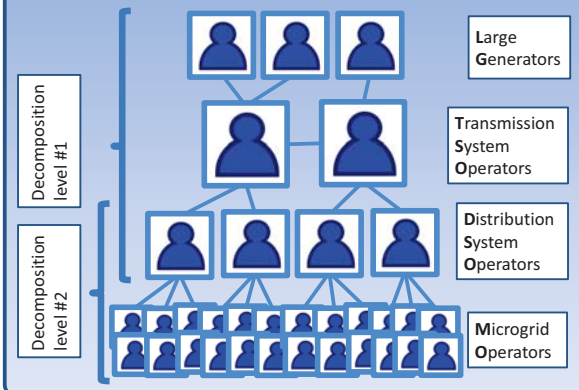
- A variety of IEEE networks of up to 300 buses and an approximately 700 buses representation of UK network
- Test on both normal and contingent conditions

How fine-grained can we go?

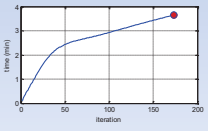
- Different systems exhibit different convergence speed but larger is not slower
- Performance case specific – contingent cases are slower



Overall Solution Structure



- Multi-agent system approach
- Two-level decomposition
- Different algorithms at each level
- The microgrid as a fundamental unit



Future Work

- Improve convergence speed
- Incorporate security constraints & ancillary services
- Search for more efficient formulations
- Look into communications aspects

References

- E. Loukarakis, J. W. Bialek and C. J. Dent, "A General Framework for Decentralized Energy Trading in Electricity Markets," in *IREP Symposium on Bulk Power System Dynamics and Control*, Rethymnon, Greece, 25-30 August, 2013

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