SRC Smart Grid Research Center Thrust Area 3: Transmission & Distribution Management

CMU Electricity Conference

March 9th, 2011

T&D Management

- Key Questions
  - How will the structure of the future electric power system look like?
  - What needs to be changed from the operational perspective?
  - What concepts/methods need to be put in place to ensure a secure, reliable and sustainable power system?
- Challenges
  - Change in power flows (PEV/distributed generation)
  - Limited Transmission capacity
  - Controllability of flows
  - Coordination across areas (communication, data exchange)
  - Distributed generation and storage devices, participating load
  - Intelligent participants / local activities
  - Variability and intermittency of renewable generation
  - …

T&D Management

- People
  - Electric Power Systems
  - Control
  - Software Engineering
  - CAD, energy aware computing
  - Optimization, Machine Learning
  - Building Instrumentation, sensors

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Ongoing Projects

- Nonlinear Control of FACTS Devices for Transient Stabilization
  - Develops control for stabilizing system dynamics during and after large equipment faults
- Dynamics of Future Electric Energy Systems with Phasors and Dynamic Line Rating Units
  - Novel concepts for modeling system dynamics driven by novel dispatch supported by fast and accurate measurements and sensors
- Optimal Usage of Existing Transfer Capacity Using FACTS Devices
  - Develops scheme based on machine learning to determine the optimal setting of power flow control devices to optimally use existing transmission capacity
- Distributed Control for Electric Power Systems to Enable the Integration of Renewable Energy Sources
  - Coordination across areas to take advantage of overall balancing resources

Project Ideas: Demand Dispatch*

Bruce Krogh, Mario Berges

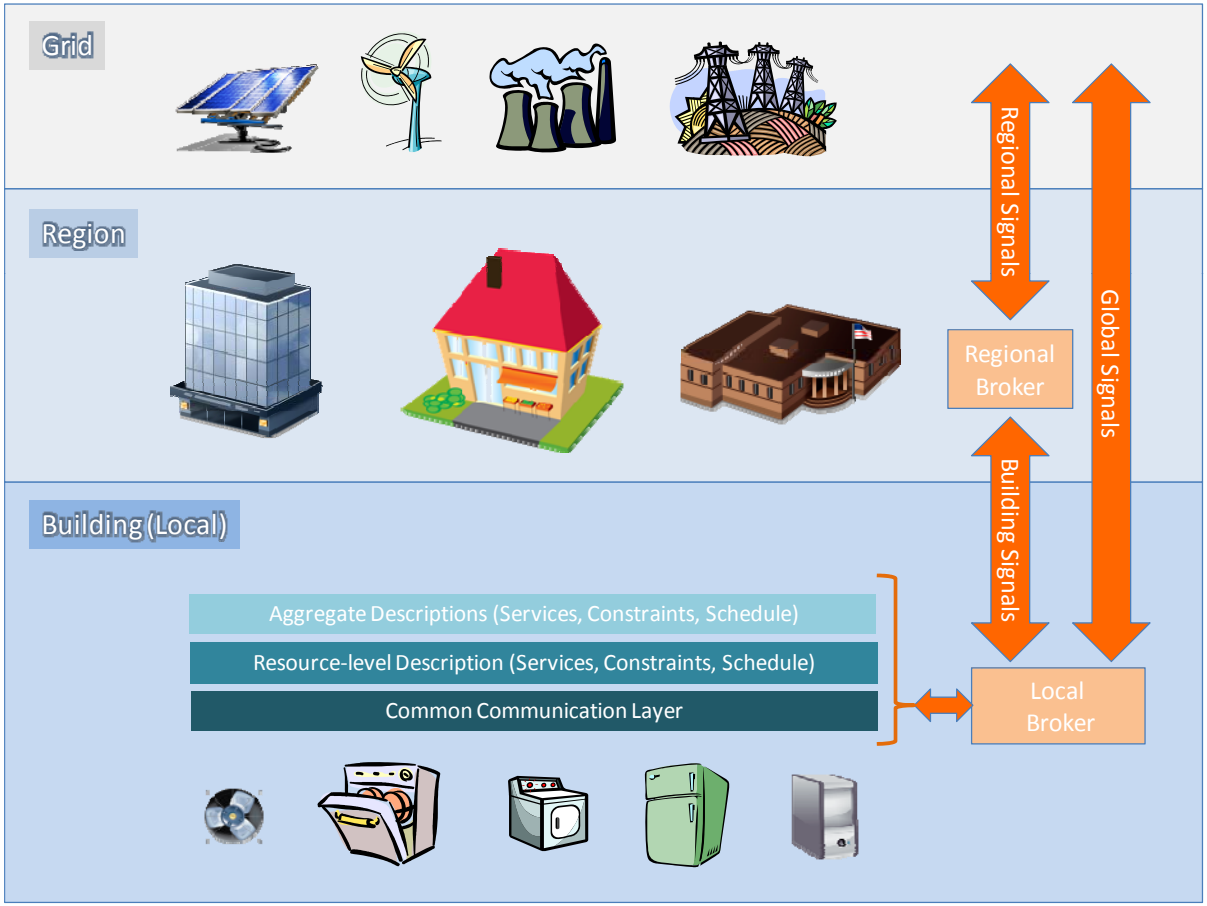
Goal: Using smart end-use devices to provide ancillary services to the grid (e.g., frequency regulation).

Potential advantages

- fast response
- low cost

Research issues

- aggregate behavior of 1000's of devices
- distributed/centralized communication and control protocols



* A. Brooks, E. Lu, D. Reicher, C. Spirakis, and B. Weihl, "Demand Dispatch," Power and Energy Magazine, IEEE, vol. 8, no. 3, pp. 20-29, 2010.
* Callaway, D.S.; Hiskens, I.A.; , "Achieving Controllability of Electric Loads," Proceedings of the IEEE , vol.99, no.1, pp.184-199, Jan. 2011.

Project Ideas: Intercoupled Systems

Gabriela Hug

Goal

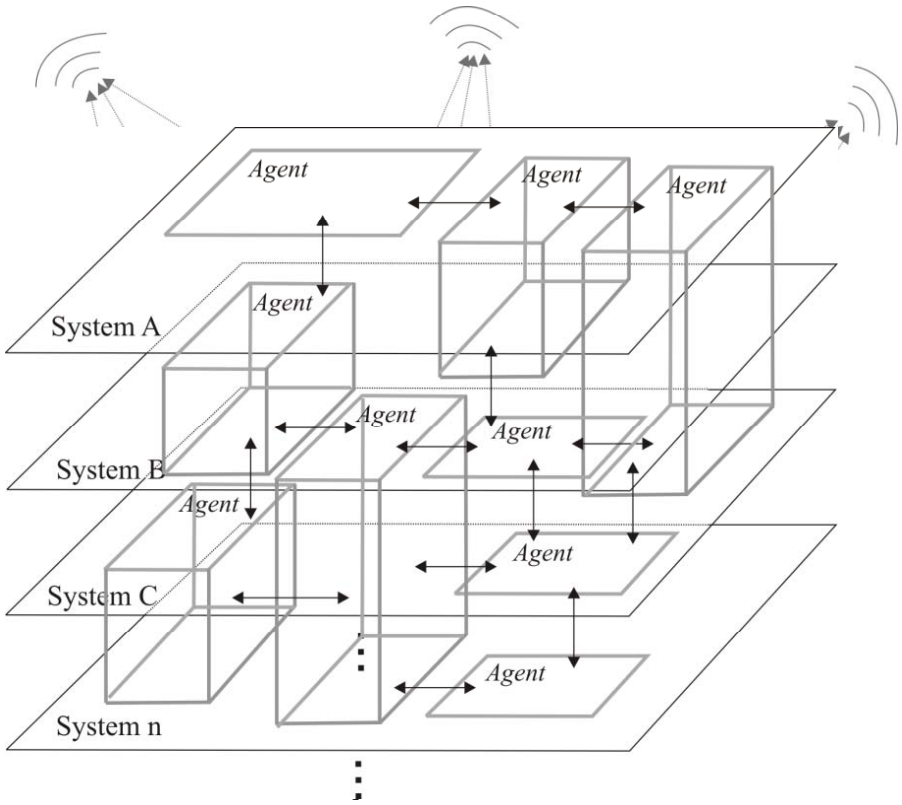
- Control Scheme for optimal coordination of intercoupled systems

Potential advantages

- Optimal usage of available devices
- Integration of intermittent renewable resources and PEV

Research issues

- Distributed, predictive control
- System complexity/ modeling
- Data exchange



Project Ideas: Managing Intermittent Energy Generation With Storage

Yangfang Zhou, Stephen F. Smith, Allen Scheller-Wolf, Nicola Secomandi

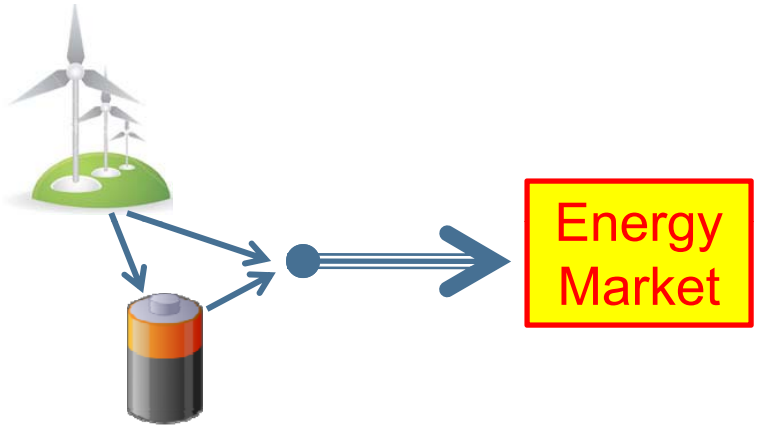
Objective: Optimal policies for managing intermittent energy production in the presence of storage

Basic Assumptions:

- *Stochastic energy prices*, to provide more reliable basis for predicting future prices
- Account for *negative prices*, a unique characteristic of energy markets

Approach:

- Exploit prior work that has established the optimal trading policy for a storage facility sitting next to the market [Zhou, Scheller-Wolf, Secomandi, Smith 2011]
- Extend to more complex setting with transmission constraints



Evaluation and Analysis:

- Focus on wind energy production
- Use financial engineering model to calibrate price evolution model to historical information (NY ISO price data)
- Asses value of storage and transmission capacity tradeoffs