MicroMarkets and Transactive Energy — A Phased Approach

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Goals

• Show
  – How to use transactive energy and micromarkets to assemble and subdivide microgrids
  – A phased approach for the processes
  – Resilience to failure
• Illustrate dynamic re-configuration
• Contrast Bottom-up and Top-Down Deployment
Background

- Structured Energy—microgrids form a topology, so differences and unions are also microgrids
- Microgrids deliver the business value of smarter grids and collaborative energy
- Micromarkets balance local supply and demand
- OASIS Energy Interoperation and its TEMIX profile connect with (micro)markets
  - Actors are “pre-integrated”—can work together in markets and for DR/Regulation and provide better managed energy by configuration, not re-coding
Microgrids and Energy

- Microgrids address management of energy use, storage, and production
- Energy transactions must include delivery
  - Direct or indirect—see Structured Energy
- Inflows and outflows from each microgrid for analysis and balance
- Differing levels of detail and abstraction
  - Microgrid containment logical consequence
Up and Down a Hierarchy

• Each microgrid has component parts
• Some components can work together to
  – Regulate, store, manage, consume, and provide energy
  – And may themselves be a microgrid
• Think of a tree that reflects inclusion
  – Subdivide to get a lower level
  – Assemble or join to get a higher level
Example: Microgrid Nesting

- Energy flows among microgrids
- Applying structured energy, if there is at least one microgrid nested in the containing one, there must be at least two
  - Example: Philadelphia Navy Yard with shipyard microgrid contained
  - There is at least the complement of the shipyard which is also a microgrid, and may be more
  - Switching and separation with micromarkets to manage supply and demand
How to Subdivide Microgrids

• Given a specific microgrid...
  – Consider the electrical connectivity and locality
  – Consider distribution choke points
  – Consider commonality of participant business goals
  – Ensure communication connectivity
  – Group sets of components together into sub-microgrids, trying to associate consumption with generation/supply and aligning boundaries where possible
  – Establish a market context and a micromarket for actors within each sub-microgrid
Participation and Observations

• One hierarchy for regulation, one for energy, ...
  – So levels won’t necessarily be the same
• Subdivisions and assemblies don’t need to match
  – Microgrid models, technologies will differ
  – Only integration technology needs to be the same
Example: Navy Base

- Within a Navy facility peers include
  - A ship
  - A house
  - An appliance

- The ship is a microgrid
- The house might be a microgrid
- All three participate via peer agents
Issues with Subdivision

• Boundaries may not be natural
  – Shift as needed
• Energy flows may not be roughly in balance
  – Set different boundaries
• Sufficient micromarket liquidity is important
• Business, ownership, and connectivity boundaries should guide subdivision
How to Assemble Microgrids

• Given a set of microgrids...
  – Group the microgrids with (relatively) balancing inflows and outflows
  – Balance supply and demand with a micromarket scoped to the union
  – Establish a single market context for actors within the assembled microgrid
Duality of Assembly and Subdivision

• The processes are dual, not inverses—the structure may differ
  – An assembled microgrid can be subdivided at the same or different boundaries
  – A subdivided microgrid can be assembled in the same or different ways
Phasing of Operations

- Incremental assembly for a set of microgrids
  - Combine in any order
    - Business and technical considerations apply
    - Consider net energy flows across the set
    - Consider electrical connectivity
  - Focus on commonalities of technology or purpose
    - BACnet on Floor 1 and 2...
    - Coffee pot and toaster on Floor 2 may share a common purpose with Floor 2 and not Floor 1
    - Toaster may not share an agent with Floor 2 BACnet
  - Floor 2 presents as a single, opaque microgrid
Phasing of Operations (2)

- Advantages to incremental change
  - Validate and check each step
  - Easier to try alternate assemblies
- Similar for incremental subdivision
  - Except for liquidity constraints on subdivided markets
Reconfiguration

- Reconfiguration can be
  - Structured—change the tree of microgrids
  - Dynamic—change while operating
  - Resilient—reconfigure in response to failures

- Configuration is easier than recoding
- Market is self-configuring after started
- Consistent environment allows rapid and dynamic reconfiguration as needed
  - For failure resilience and for assembly/subdivision
Needed Technology

• An interoperation approach that supports many markets
  – Flexible participation in multiple markets
  – Flexible change in market participation
  – Regulation capabilities are priced as options
    • Also need timely response and reports

• Service Oriented Architecture
  – Best practices in enterprise quality software

• Adaptable to any end node management system
Energy Interoperation

- Energy Interoperation/OpenADR2/TEMIX
  - Supports regulation, DR and DER
  - Supports markets
- Allow multiple market participation and configuration change
- Conclusion: use Energy Interoperation to provide pre-integration and transactive energy and DR/DER/regulation/projection

Bonus: Energy Interoperation at each actor allows rapid and resilient reconfiguration
Summary

• Use of Energy Interoperation enables
  – Service-Oriented interactions
  – Use of cross-cutting smart grid standards
  – Less specialized programming for services
  – Full transactive energy support at any level
  – Full Regulation, DR, and DER support at any level
  – Clean assembly and subdivision using micromarkets
  – Rapid and resilient configuration & reconfiguration

All within an interoperable standards framework

Using best practices in interoperation
Questions