


OpenADR and the Future of Energy Interoperation

William Cox, PhD
Cox Software Architects LLC
December 2010
Updated October 2012


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William Cox

- Consulting Software Architect
- Enterprise software, eCommerce
- Service-oriented Architecture
- Participant in developing NIST Smart Grid Framework and Roadmap
- Leader in collaborative energy
- Definition and structure for interoperation
- Venture and startup guidance and technologies


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Introduction

- OpenADR from Lawrence Berkeley Labs has significant deployments and mindshare
- The OpenADR approach is key to smart grid interoperability with automated responses designed in
- Energy Interoperation will have the OpenADR 2 profile
- Price and product distribution differs from event distribution
- Using an enterprise approach makes Energy Interoperation more flexible
 - Same interactions and schemas at each level
- Extending Energy Interoperation with IRC business exchanges is producing a broadly useful standard


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Managed and Collaborative Energy

- Managed Energy
 - Managed to different goals
 - Scale and control are issues
- Collaborative Energy
 - Choices consistent with business goals
 - Consider markets and requirements
 - *Ask versus tell*
- Balancing Energy Supply & Demand
- See Cox and Considine, **“Smart Loads and Smart Grids—Creating the Smart Grid Business Case,”** Grid-Interop 2009


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OpenADR

- Acronym for **O**pen **A**utomated **D**emand **R**esponse
- Lawrence Berkeley Labs project
- Funded by California Energy Commission
- See Girish Ghatikar, et al, Grid-Interop 2010


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Expanded Use Cases

- Demand Response (curtailment) events
- Price distribution
- Quote streams
- DR signals as option calls
- Transactive Energy


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OASIS Energy Interoperation Goals

- Architectural goals include
 - Clean and consistent information exchange
 - Consistent information exchange patterns
 - To, from, inside, and outside microgrids
 - Apply usage and demand standards
 - NAESB Energy Usage Information
 - Future, Present, Historic demand and usage
 - Projected or committed, real or estimated
- Use NIST-led work—cuts across the entire Smart Grid
 - Common price and product definition (EMIX)
 - Common schedule communication (WS-Calendar)


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Key Collaborative Energy Standards

- These standards are in or approaching final status:
 - [WS-Calendar](#) allows synchronization and common communication of schedules in a high level business manner
 - [Energy Market Information Exchange](#) [EMIX] defines cross-cutting price and product definition communication for the Smart Grid
 - [Energy Interoperation](#) defines DR, DER, and usage/ demand projection and measurements and price +product distribution
- All three are defined to, from, within, and outside of microgrids
- All work, interim and final, is publicly visible

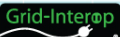
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Composable Standards

- For scalability
- For independent innovation and evolution
 - With agreed interface contracts
- For simplicity
- For reuse
- See [NIST Framework & Roadmap](#) page 48

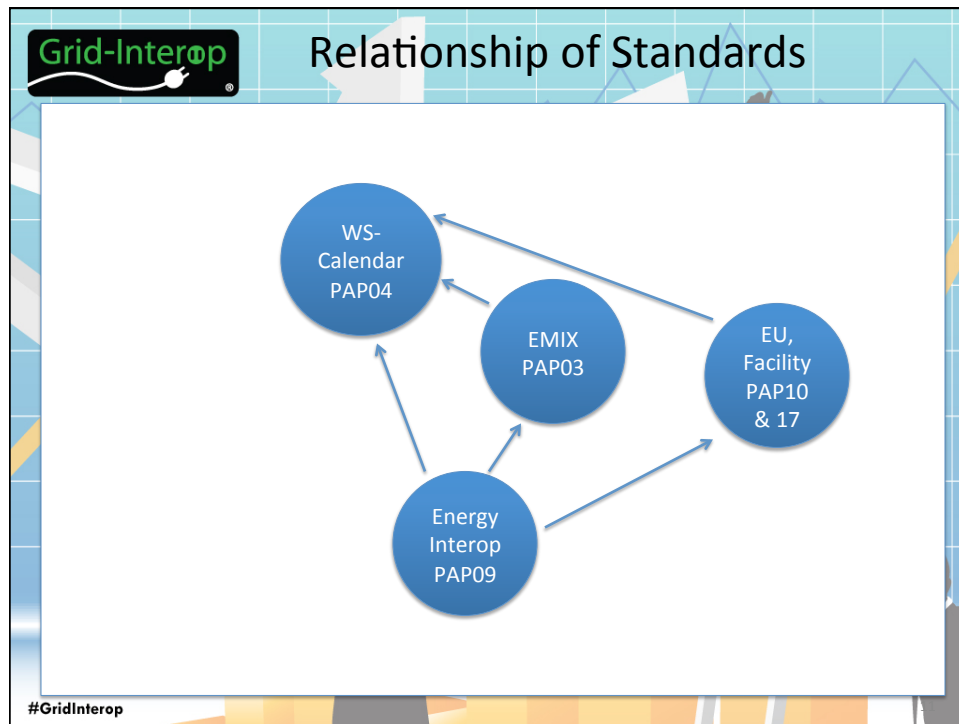
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DR Interoperation—Composition

- What to compose?
 - Price and Product Definition ***compose EMIX***
 - Schedule ***compose WS-Calendar***
 - Load and Usage ***compose PAP10 Core Standard***
 - Meaning of signals ***in Energy Interop***
 - Means of communicating ***in Energy Interop***
 - Security ***compose WS-Security and more***
 - Varies for different interactions
 - Privacy issues
- Where to you compose? Application? Standard?
- Long and short term perspective

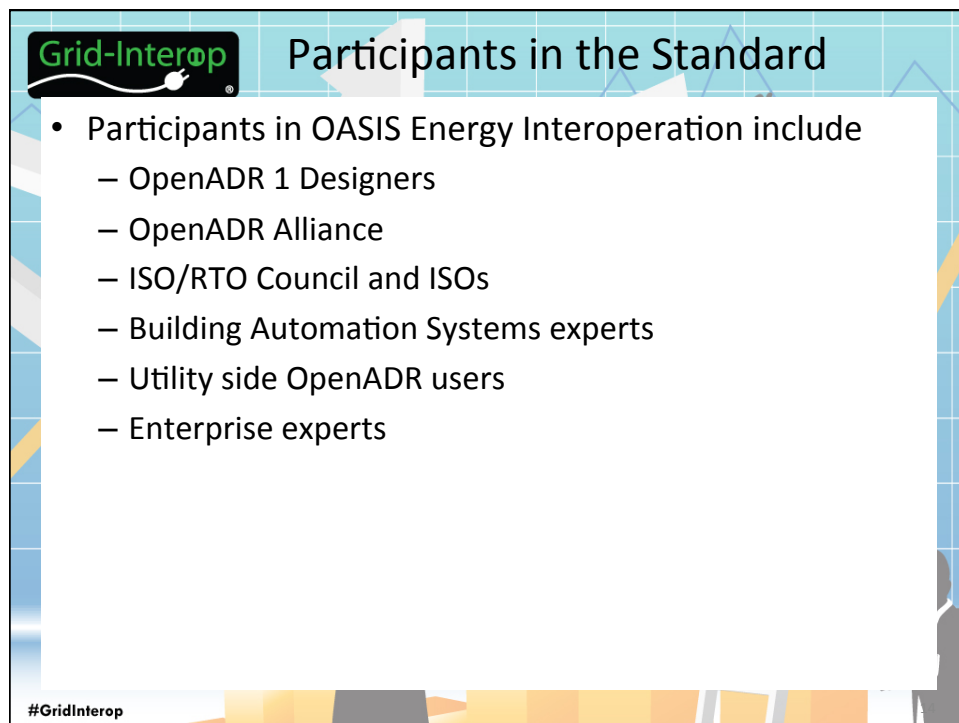
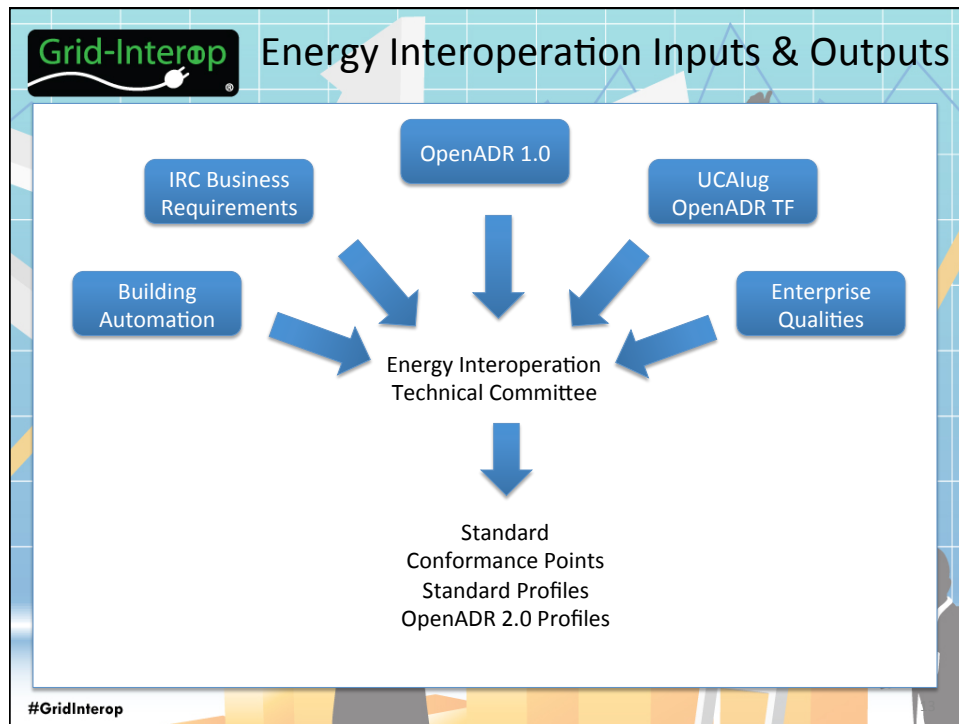
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Grid-Interop OASIS

- OASIS is the leading standards organization for
 - XML vocabularies
 - Web services
 - eCommerce
- Open—all work, emails, meeting minutes are available on the web
- Great care in Intellectual Property protected standards
- <http://www.oasis-open.org/>

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Grid-Interop Architectural Overview

- *Actors* are the basis for computation and interoperation
- Actors take on *roles*
- The terminology of transactive markets
- Business roles—*Buyer* and *Seller*
 - Any actor can take on Buyer or Seller role
- Relationship roles—Virtual End and Virtual Top Nodes
 - VTN and VEN (See EPRI White Paper)
- Services, not APIs
 - Consistent with SOA approach

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Grid-Interop Virtual Top and End Nodes

- A VEN has exactly one VTN in a given relationship
 - Energy Interoperation defines relationships as *MarketContexts* (mostly a URI)
- A VTN has one or more VENs in a given relationship

```
graph TD; VTN((VTN)) --> VEN1((VEN)); VTN --> VEN2((VEN)); VTN --> VEN3((VEN)); VTN --> VEN4((VEN));
```

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Grid-Interop Composing More Complex Patterns

- An Actor can take on the role of both a VTN and a VEN
 - B, E, G are actors presenting both the VTN and VEN role
- The VEN role can participate in >1 market context
 - L is a VEN to E and G in different market contexts

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Grid-Interop More Than Utility-Customer

- F, G, H are second level aggregators and B's customers
- L is also E's customer

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Grid-Interop More Than Aggregator-Customer

- B, C, D, E are first level recipients
- F, G, H are real estate firms that receive signals from B
- I, J, L are G's tenants
- L also receives signals directly from E

The diagram illustrates a signal distribution network. It is organized into four columns: 'Operator issuing a DR signal', 'First Level Recipients', 'Real Estate Firms', and 'Tenants'. Node A (Operator) sends signals (labeled VTN) to nodes B, C, D, and E (First Level Recipients). Node B sends signals (labeled VEN) to nodes F, G, and H (Real Estate Firms). Node G sends signals (labeled VEN) to nodes I, J, and L (Tenants). Node E also sends a signal (labeled VEN) to node L. Nodes C and D are shown but have no outgoing connections.


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Grid-Interop Price Distribution

- A is a microgrid-scoped market operator distributing price to B, C, D, and E
- B distributes prices to controllers F, G, H that manage floors in its building
- I, J, L are HVAC units on floor G
- L also receives price from E who is a different market

The diagram illustrates a price distribution network. It is organized into four columns: 'Market Operator', 'Direct Price Recipients', 'Floor Controllers', and 'HVAC Units on Floor G'. Node A (Market Operator) sends prices (labeled VTN) to nodes B, C, D, and E (Direct Price Recipients). Node B sends prices (labeled VEN) to nodes F, G, and H (Floor Controllers). Node G sends prices (labeled VEN) to nodes I, J, and L (HVAC Units). Node E also sends a price (labeled VEN) to node L. Nodes C and D are shown but have no outgoing connections.


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Same Services, Same Patterns

- In each example the service operations flow across the VTN-VEN edge
- In each example, some Parties have multiple relationships
- Any actor can be a buyer or a seller


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Issues in Energy Interoperation (1)

- Issues from the last part of the standardization included
 - Resources, assets, and looking “inside the VEN”
 - Business issue: dangerous, and adds complexity to look beyond the VEN interface
 - Registration and its meaning for wholesale and retail
 - Adopted abstract registration/enrollment service
 - Price as a multiplier or adder to base prices
 - Both are defined
 - Requested response level communication
 - Report mechanism addresses DR, Regulation, projection, more


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Issues in Energy Interoperation (2)

- (continued)
 - Addressing all IRC requirements
 - Application support for OpenADR Simple Clients for faster uptake
 - Structured for both pull and push patterns
- Historical and Current Issues are tracked at <http://tools.oasis-open.org/issues/browse/ENERGYINTEROP>

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Conclusions

- OASIS Energy Interoperation is the place where OpenADR, IRC, and other requirements are addressed
- The architectural approach covers many use cases, far beyond “utility-customer”
- OpenADR functionality is defined as a profile on Energy Interoperation
 - Used as context for OpenADR Alliance profiles
- Using NIST-identified Smart Grid cross cutting standards will improve interoperation
- One freely-available standard addresses interoperation
 - Between pairs of smart/microgrid actors
 - Transactive energy and operation

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