Applying EI/EMIX to DR and Transactive Energy

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Grid Interop 2012, Irving, TX

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DR and EI Goals

- We want to see the customer/ “prosumer” be an active participant in the smart grid.
- Enable unforeseen technologies and new actors to participate in making the grid smart.
- Move the information needed for DR in an IT-friendly way.
- Decouple the actors’ and their implementation/ update/deployment.

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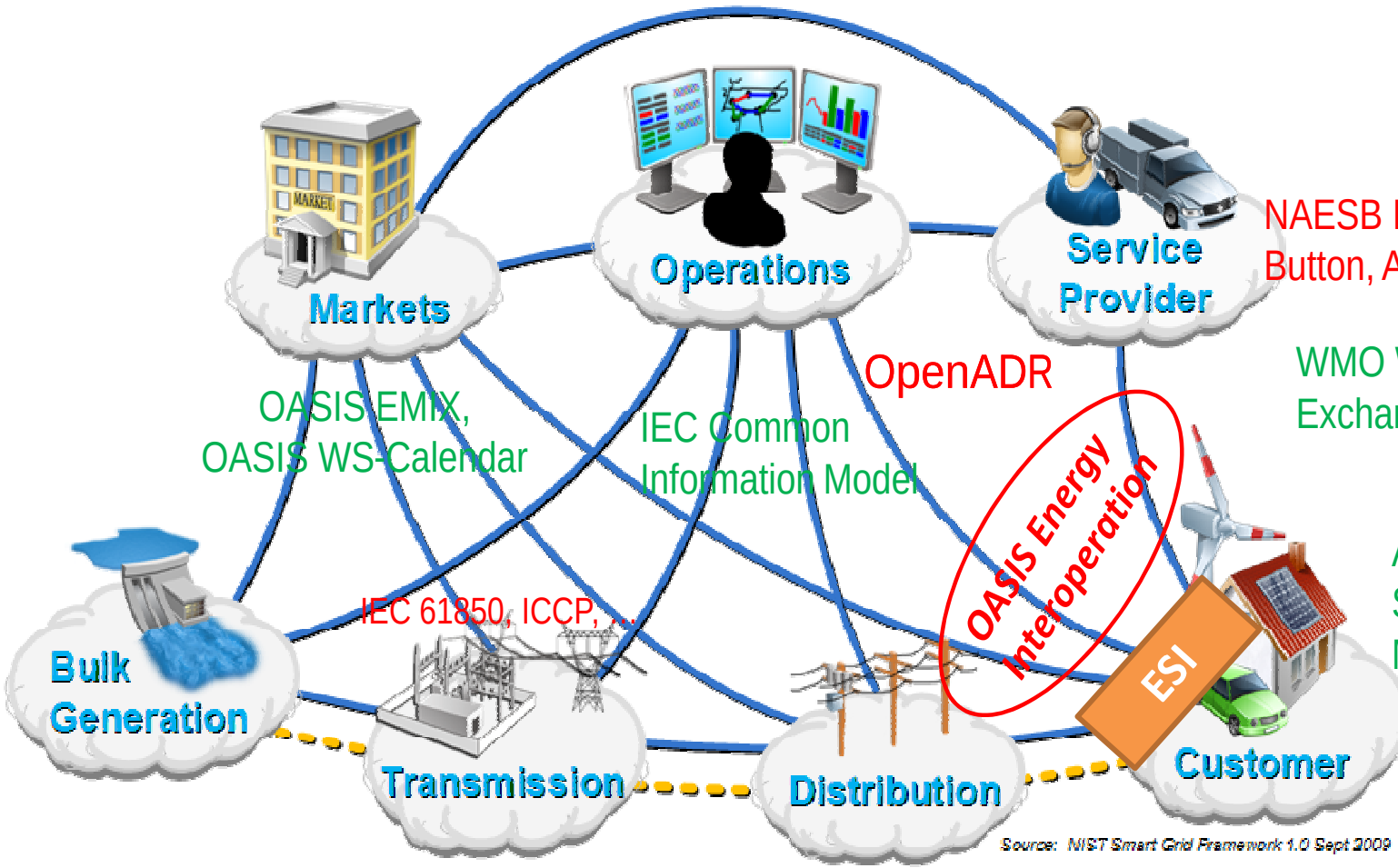
Smart Grid Domains and existing standards



NAESB ESPI/ Green Button, AS/NZS4755

WMO WXXM Weather Exchange Model

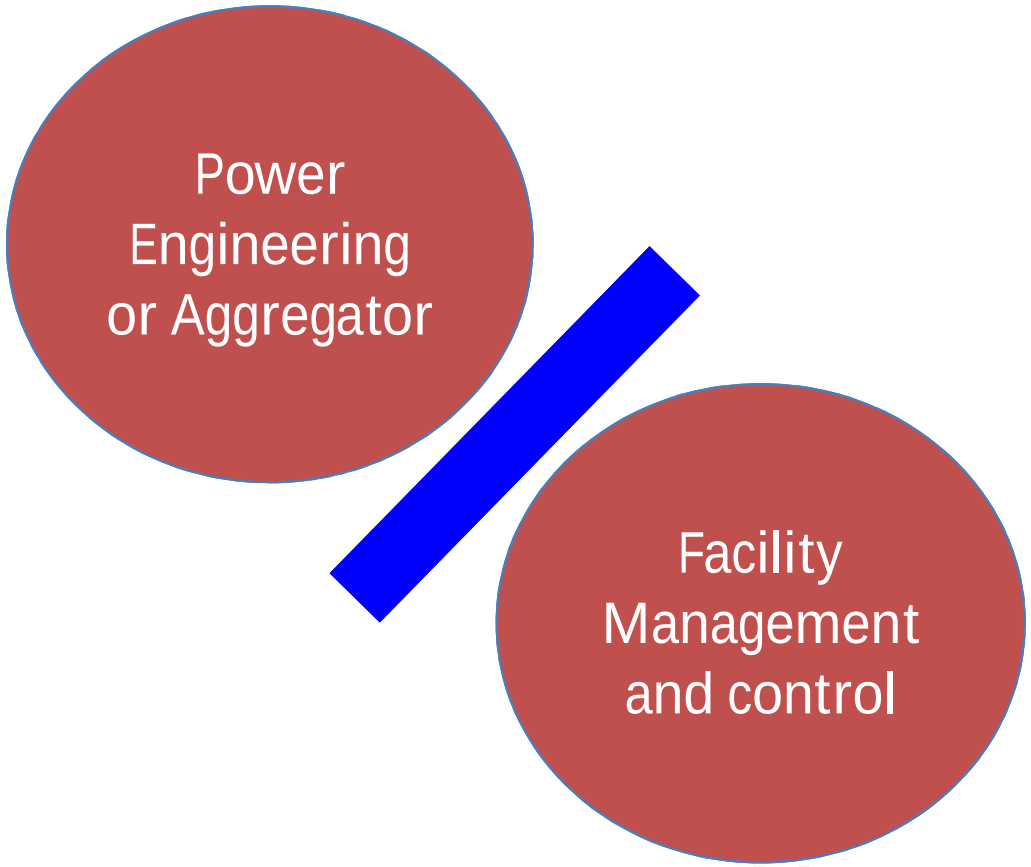
ASHRAE Facility Smart Grid Information Model SPC201P

- ASHRAE BACnet, LONtalk
- ECHONET, SEP 2.0
- Modbus, Profibus
- OPC-UA, ISA standards
- CEA 2045
- ...

Energy Interoperation was designed to serve DR and market interactions within the Smart Grid.

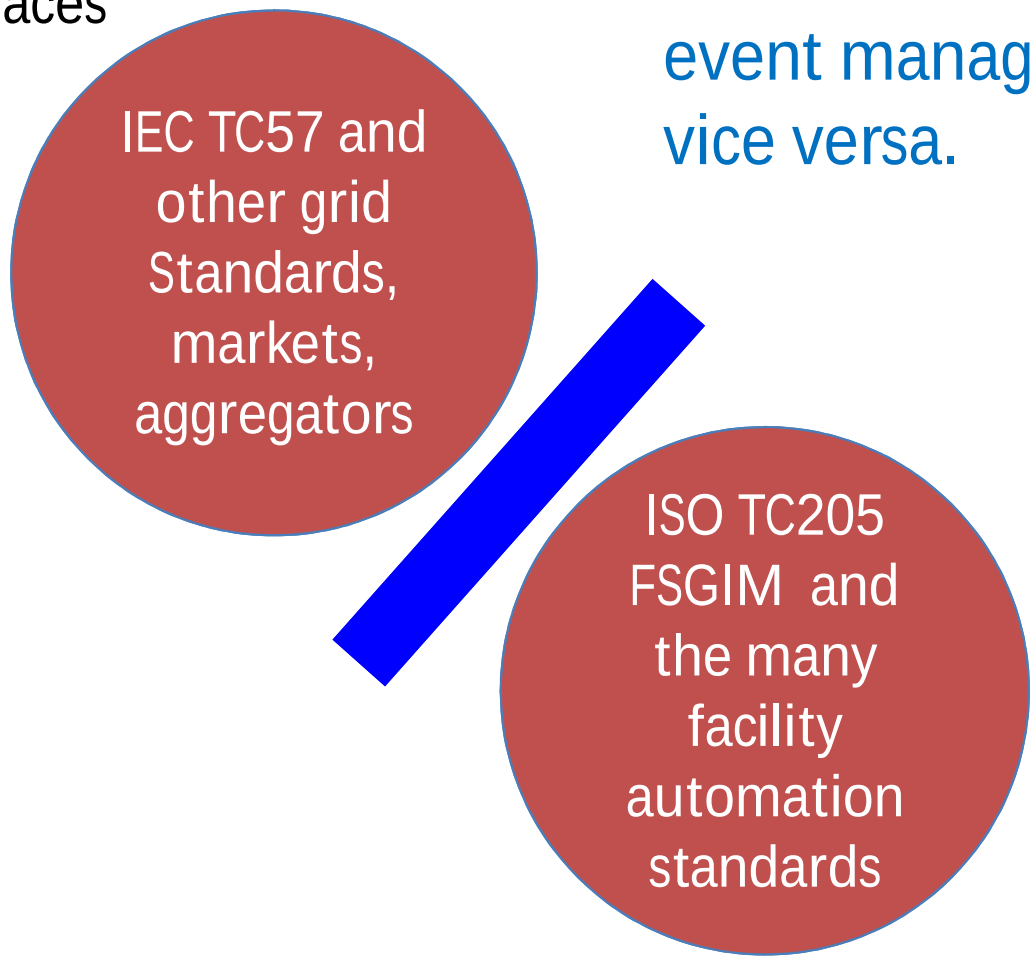
Interoperation Considerations

- Different smart grid domains are different worlds with different information models and communication standards stacks.



Different domains

Markets, Grid operations, other VTNs in facility and aggregator spaces



We don't want to extend BACnet to talk to the utility back-end DR event management system or vice versa.

FSGIM, BACnet, KNX, LON, ECHONET, ISO/IEC JTC1 standards, and many many more

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Different Domains and Software Evolution

- New technology must work in parallel with the old for a while
- Users want to make their own decisions about transition times and techniques
- Users need to evolve and upgrade and maintain on a schedule that matches their business needs
- Small services that do one thing well (e.g. authentication) are easier to reuse
- Technologies as yet unknown must work with today's systems

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How to Integrate

- The waist of the hourglass—Shallow Integration
  - Simple services
  - Minimal interface
  - Abstracted at the right level
  - Don’t try to integrate with everything on the other side, just the right things

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Actors and Information

Energy Services Interface Actors and Information Exchanged

External Service Providers *

- Wholesale Markets
- Retail Service Provider
- Curtailment Specialist
- Distribution System Operator
- Micro-Grid

Facility Service Consumers *

Facility service gateway

- Residential gateway, EMS
- C&I EMS or other business system

Facility device information model

Loads:
- Systems
- Equipment
- Appliances
- Devices
- Electric Vehicles

Storage:
- Active
- Passive

Generators:
- Variable
- Non-variable

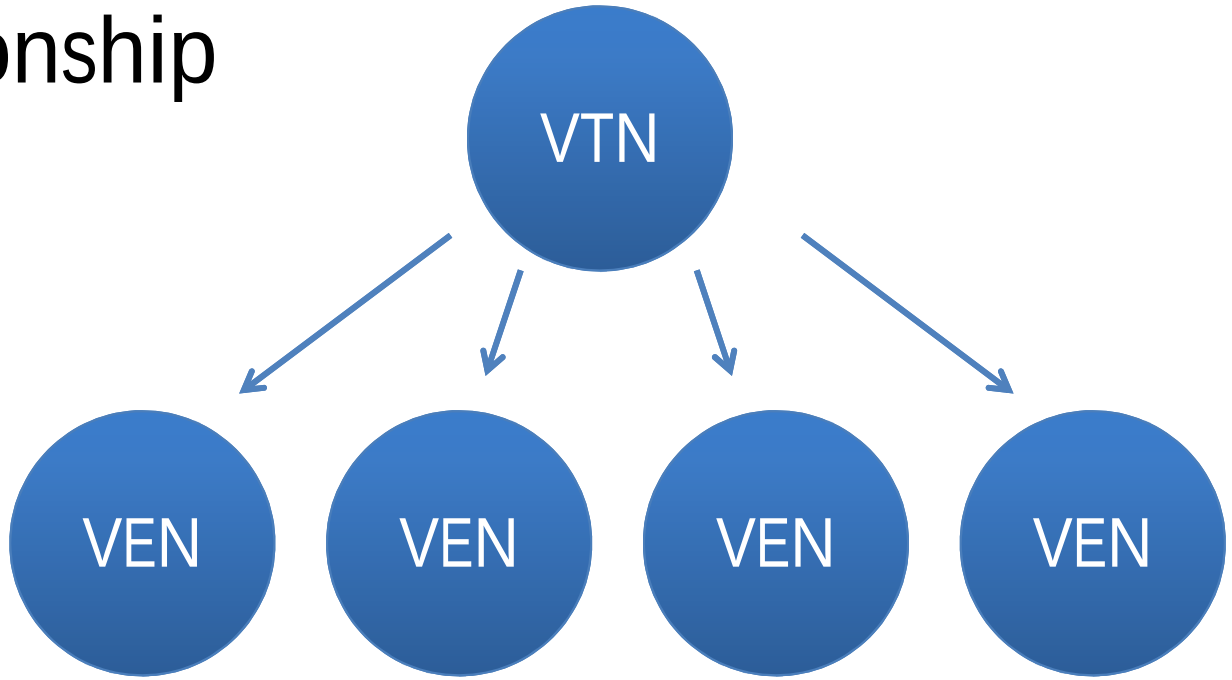
Meter [3]

[1] DR event notification, start time, duration, shed level/ price, bid acceptance
[2] Energy usage, per NAESB ESPI standard provides validated meter data from utility back end.

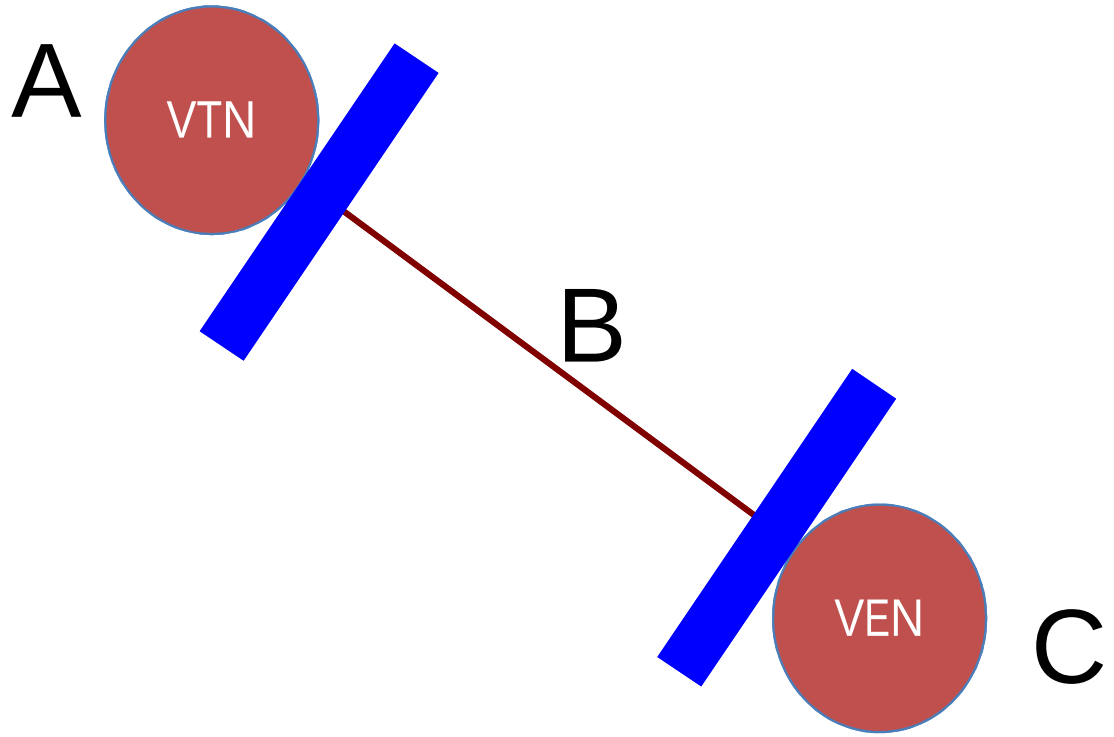
[3] The meter shown here in the facility domain is a sub-meter. The utility revenue meter may also provide data to the facility owner using the facility meter data model.
*The service providers and consumers listed here are given as examples and not meant to be comprehensive.

EI's Simple Architecture

- Energy Interoperation/EPRI terminology
- A VEN has exactly one VTN in a given relationship
- A VTN has one or more VENs in a given relationship



DR Signal Distribution Overview



VTN=Virtual Top Node
VEN= Virtual End Node

- A: Source of DR signal (price, event, etc.)
- Blue Lines—Energy Interoperation services
- B—Communication
- C: Recipient of DR Signal (e.g. Device/Facility EMS)

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Same Services, Same Patterns

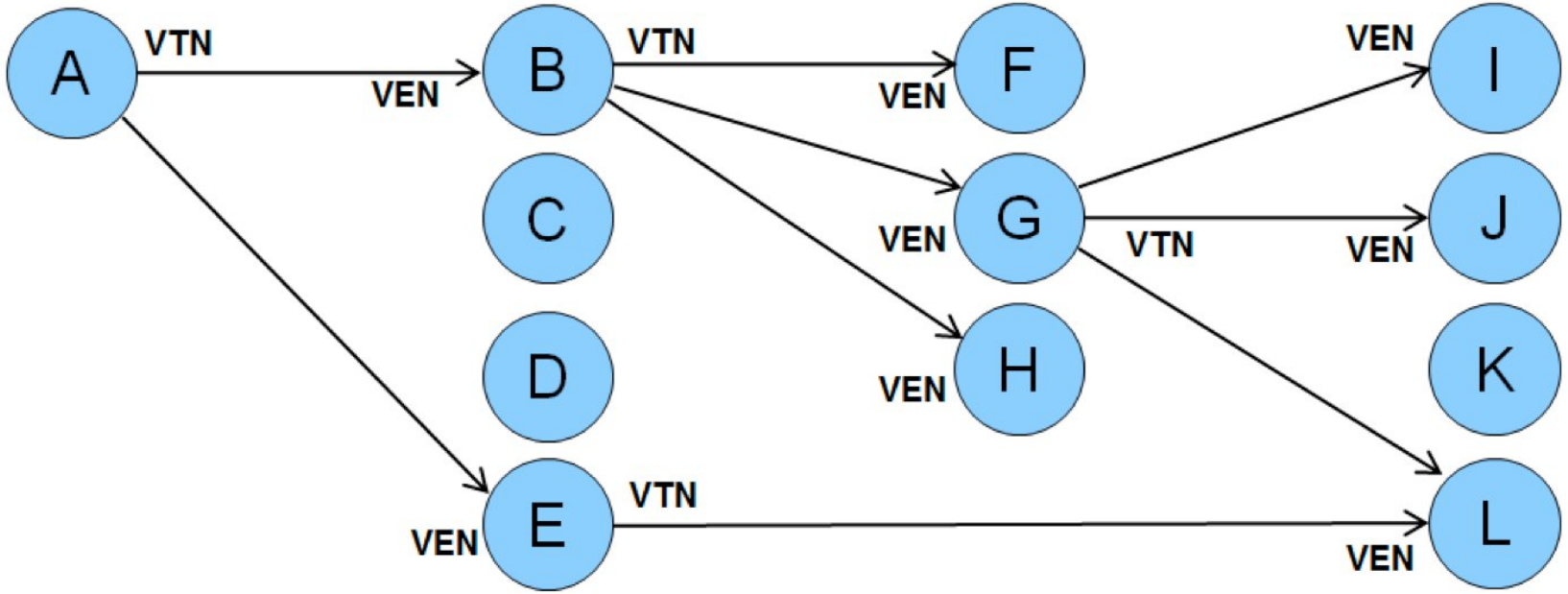
- We have a simple set of services
- The following examples are for DR event management
- Some actors have multiple roles
- Energy Interoperation also supports Transactive Control/Transactive Operation

Not Just Between "the grid" and "the facility"

Energy Interoperation can be used to build a series of interfaces along the path from source to sink.

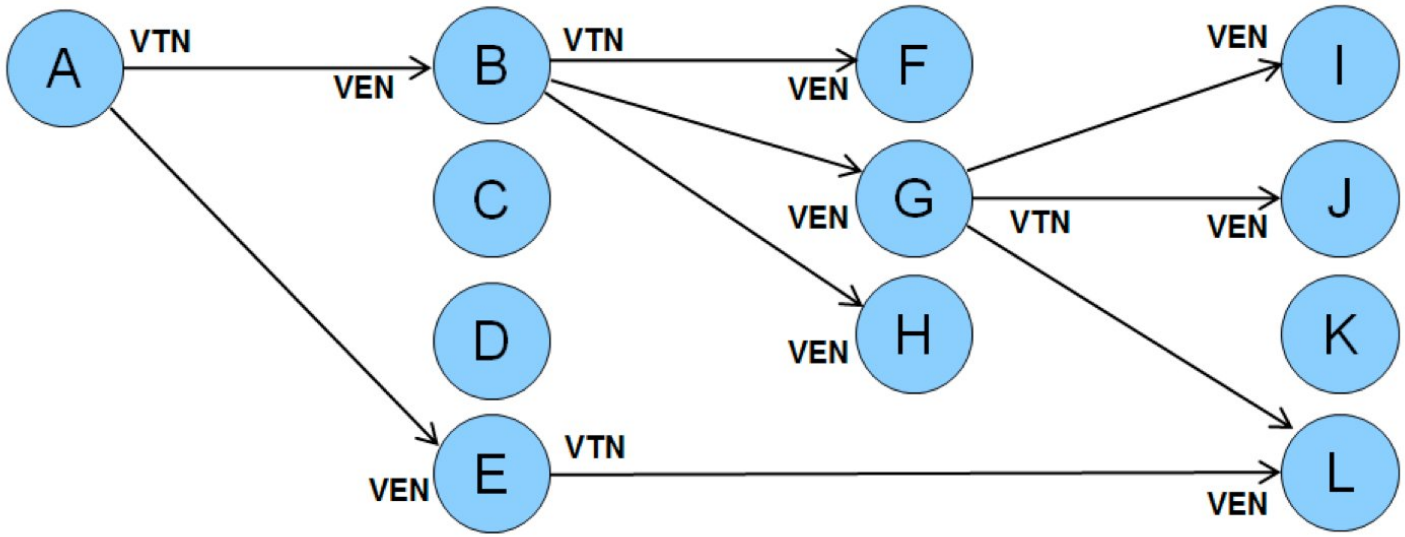
Each only knows its direct connections.

This is the "out of the paper" view



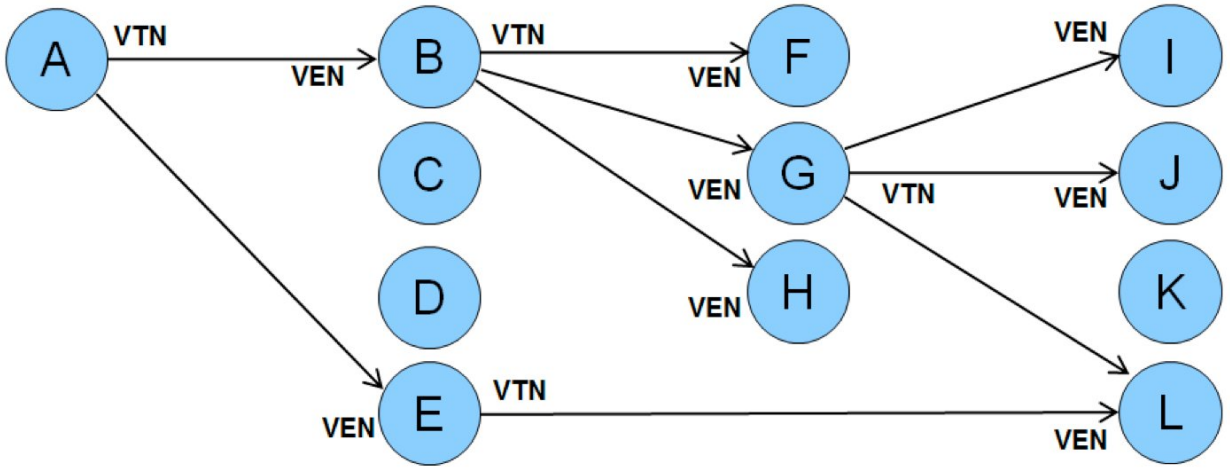
More Than Utility-Customer

- A is a wholesale market operator issuing a DR signal
- B, C, D, E are first level aggregators
- F, G, H are second level aggregators and B's customers
- I, J, L are stores and are G's customers
- L is also E's customer



Example: Price Distribution

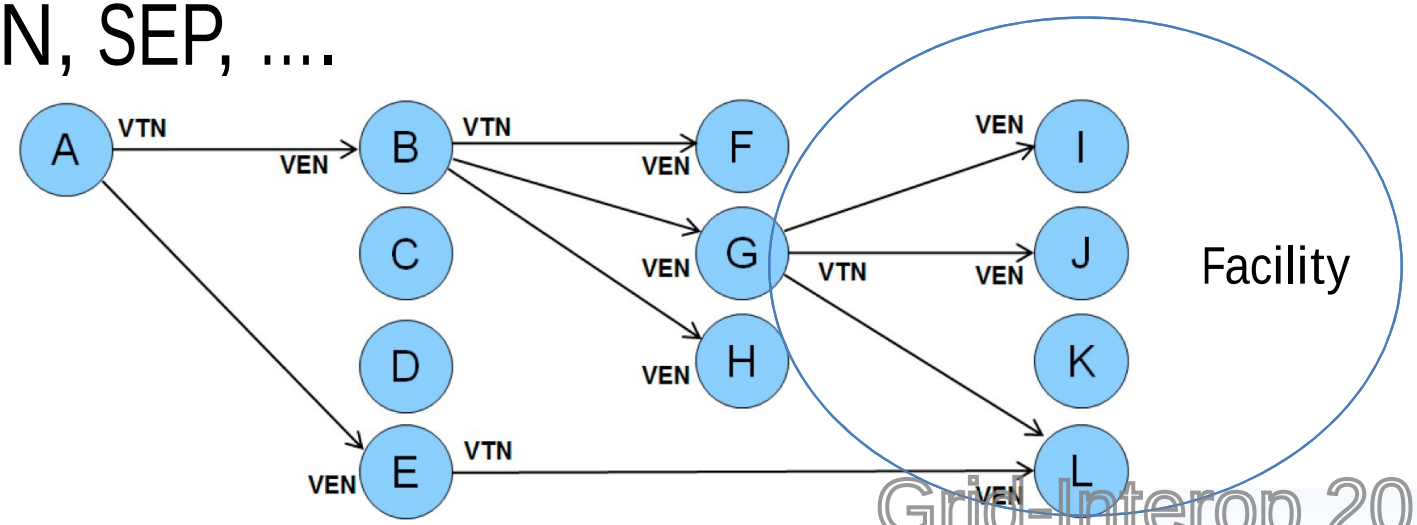
- A is a market operator distributing prices to B, C, D, and E
- B is a building price server that distributes prices to controllers F, G, H that manage floors in its building
- I, J, K are HVAC units on floor G
- L is a thermal storage unit that can run on alternate fuel supply with price from E.



Boundaries Depend on Deployment

Energy Interoperation can be used within facility domain

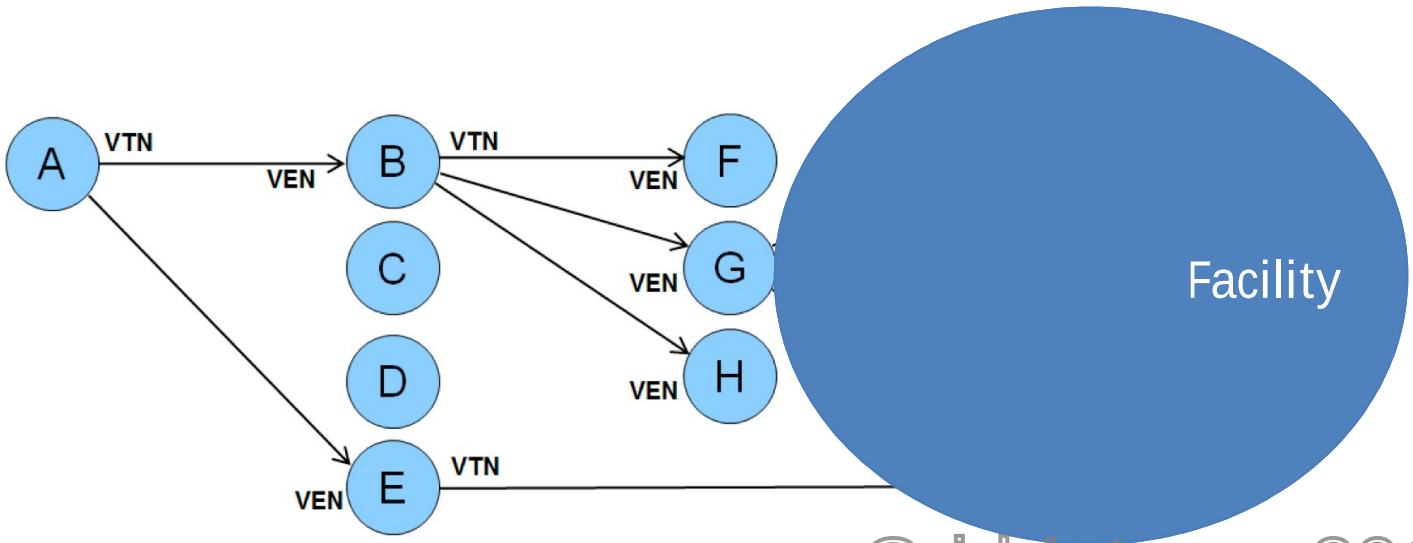
- G is a Facility ESI
- I, J, K, L are components of the facility and produce or consume energy
- Service Requests go to G, which adjusts them and then distributes them to I, J, K, L
- Information at ESI can be distributed with EI, BACnet, LON, SEP, ….



Boundaries Depend on Deployment

EI outside of facility domain

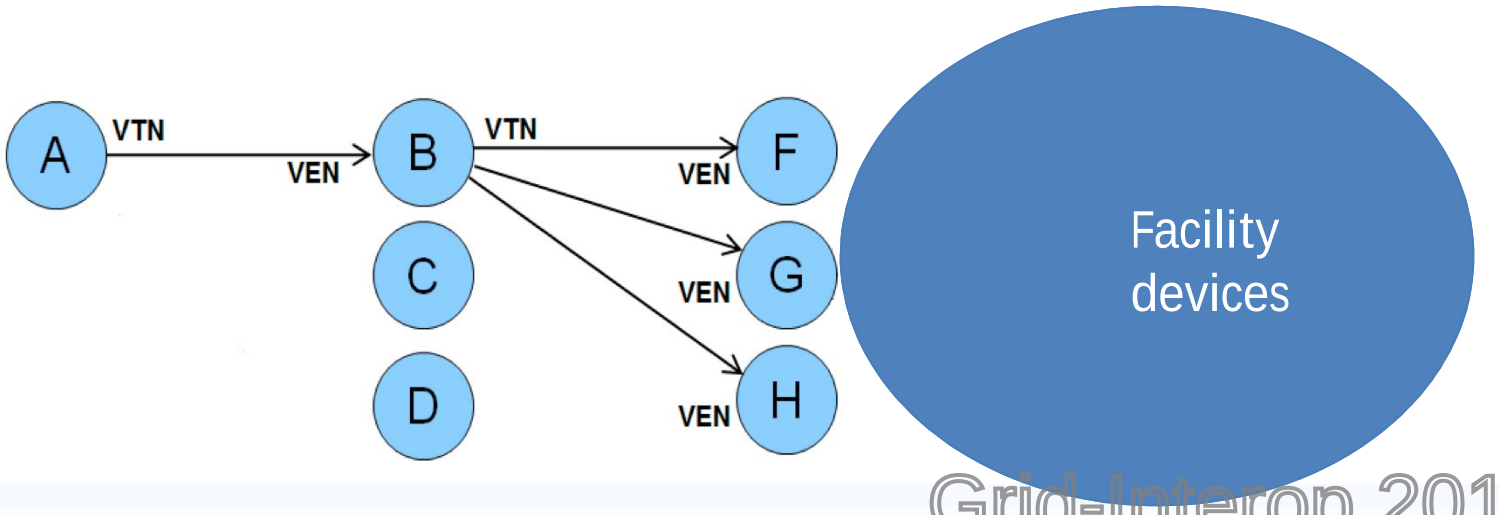
- G is a Facility ESI
- Information is at ESI, can distribute with BACnet, LON, SEP, ….



Cloud Deployment

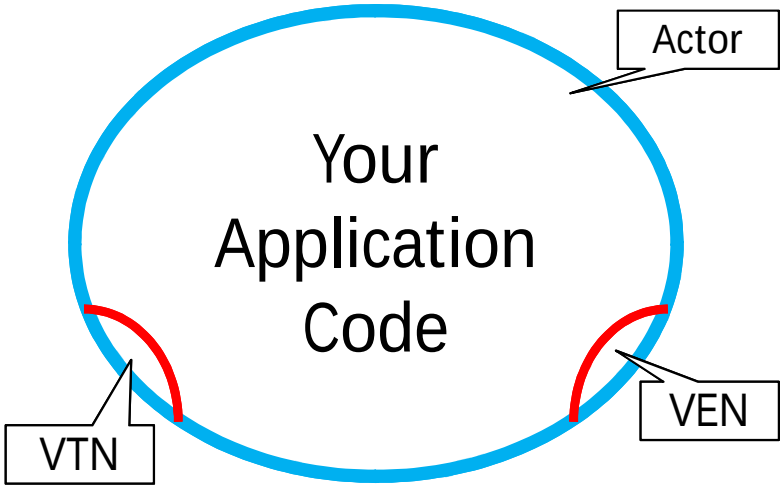
Remote Energy Management in the Cloud

- A is wholesale market sending DR signal
- B is retail utility
- G is a remote Building EMS in the cloud
- Facility energy management is performed by G talking to facility components



Decouple at the Red Boundary

- Application code evolves on its own timeline
- The VEN/VTN interfaces and information model is stable
- Define a clear mapping between your application code and the Energy Interoperation service interfaces



(not to scale)

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Integration Across Many Standards

- Must be able to integrate information models in the systems of actors presenting the VEN and VTN interface
- Cannot extend each actors' interfaces and models
  - They don't work with each other at details
  - Viz. "Internet Terminal" problem and solution
- Extract key information to communicate
  - See Grid-Interop 2011 paper on DR event core semantics

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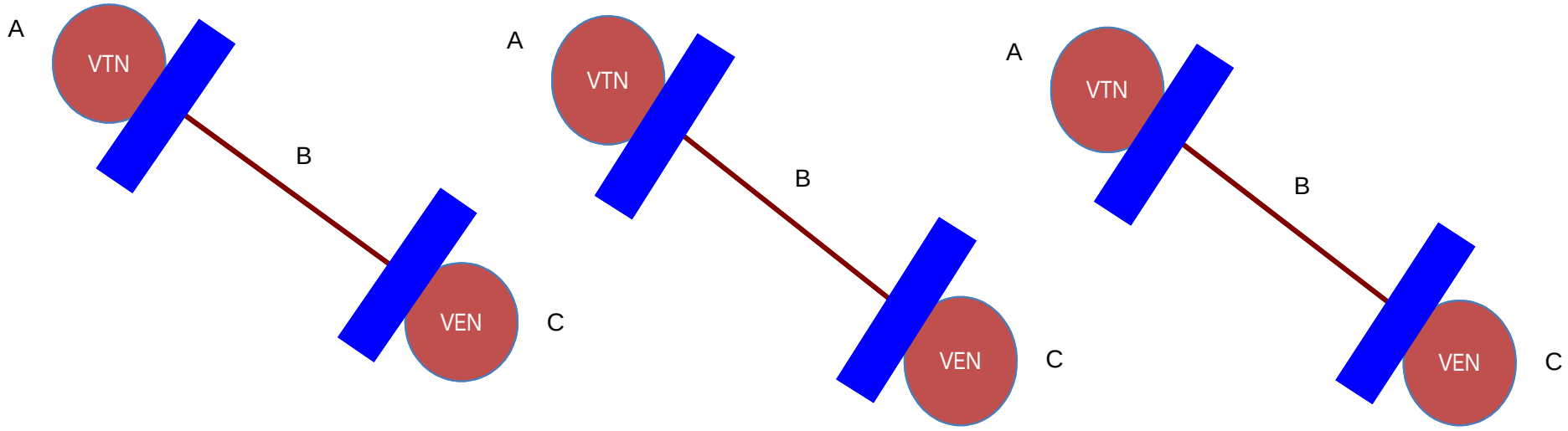
Node Implementations

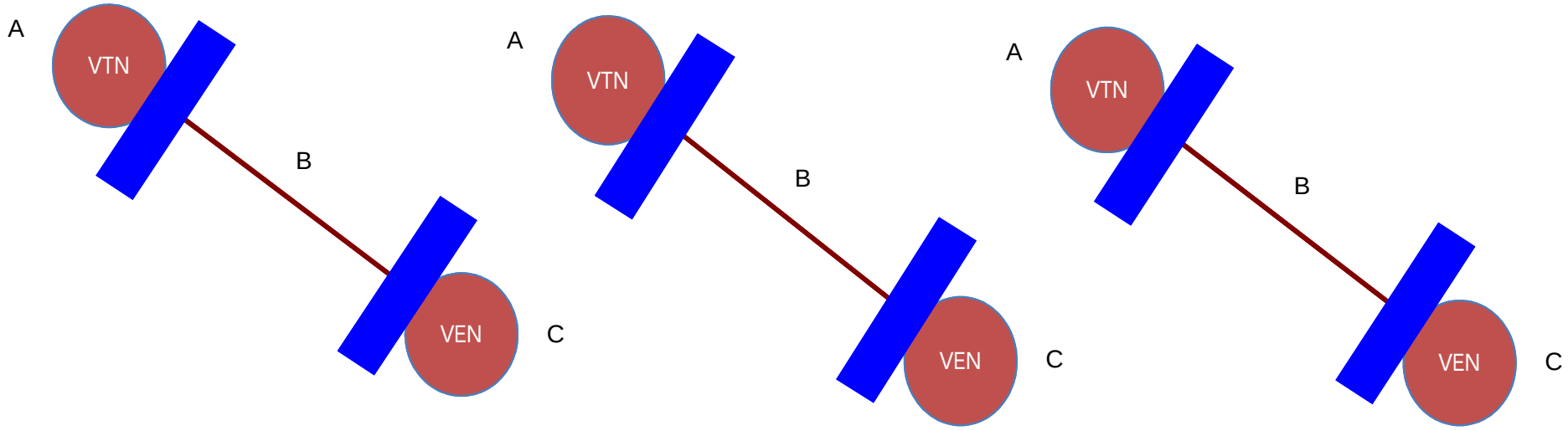
- There is great diversity of Virtual End Nodes (facilities, etc)
  - Industrial
  - Commercial/Institutional
  - Residential
  - And hybrids
- Large investments across the world
- Integration with existing management systems is critical to success

Specifications for Actors—VENs (1)



- ISO 16484-5 (BACnet)
- ISO/IEC 14543-3 (KNX)
- ISO/IEC 14543-4 (Echonet)
- ISO/IEC DIS 14908 (LONtalk)
- ISO/IEC 15045 (Residential Gateway)
- ISO/IEC TR 15067 (Energy management HES)
- ISO 18012 (Product interoperability guidelines)

Specifications for Actors—VENs (2)



- IEC 62056-61/62 (Metering, tariff)
- ISO 20022 (Financial systems)
- oBIX (Building automation and integration)
- ISA 100, etc (Industrial)
- OPC UA (Industrial)
- Smart Energy Profile
- ISO CD/ASHRAE SPC201P (Facility Smart Grid Info Model)

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Conclusions

- Energy Interoperation/OpenADR designed to be an integration interface to communicate the needed DR event information and market transaction information to enable facility integration into the smart grid.
- Built on sound software architecture principles
- Interface decouples information model and protocols on one end from other end.
- Minimal information transfer hides complexity
- 2-party interaction that can be chained together to serve multiple actors to build different delivery paths and different DR approaches