Interoperation of Transactive Energy and Other Smart Grid Standards

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Grid-Interop 2012

Agenda

- Characteristics of Transactive Energy Systems
- Interoperating with Smart Grid Standards
  - Input Standards
  - Output Standards
  - Signaling Standards
- Interface Mapping Methodology
- Conclusions

CHARACTERISTICS OF TRANSACTIVE ENERGY SYSTEMS

Transactive Energy Definition

Transactive energy approaches use economic or market based constructs to manage the generation, consumption or flow of electric power within an electric power system while considering grid reliability constraints.

Transactive control & coordination

- Coordinates operation of distributed assets to meet multiple generation, transmission, & distribution objectives
- Manages controllable assets at the distribution level to mitigate load and supply variability

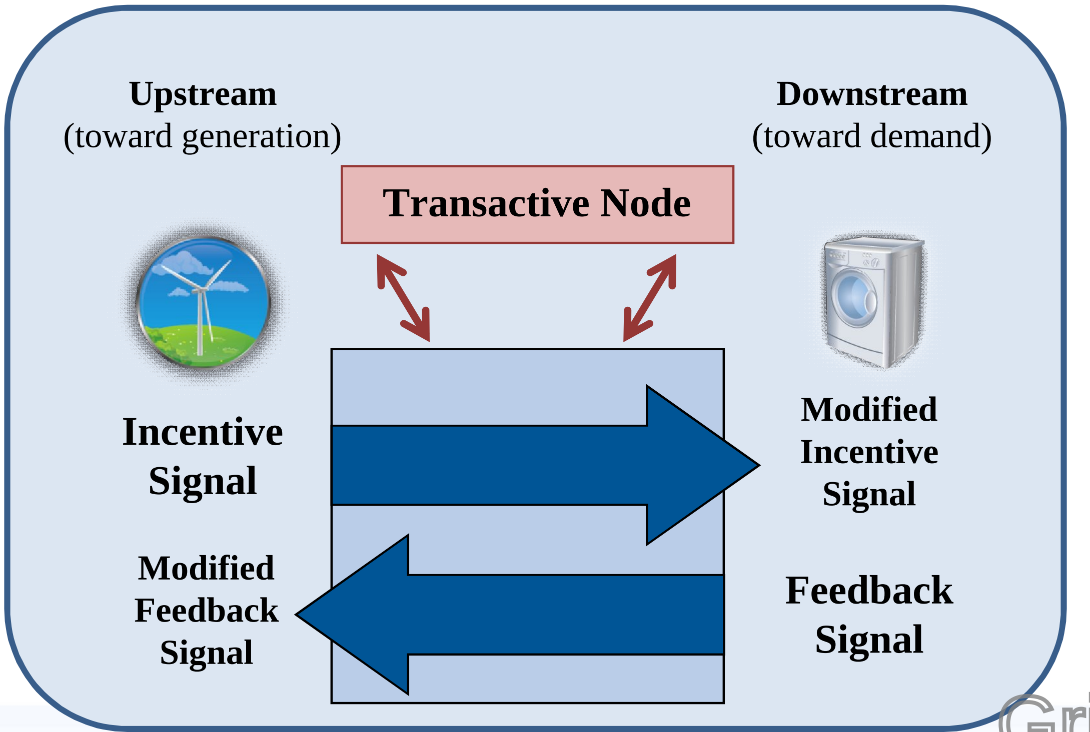
Transactive Energy 101

What is it?

- Transactive control is a distributed method for coordinating responsive grid assets wherever they may reside in the power system.

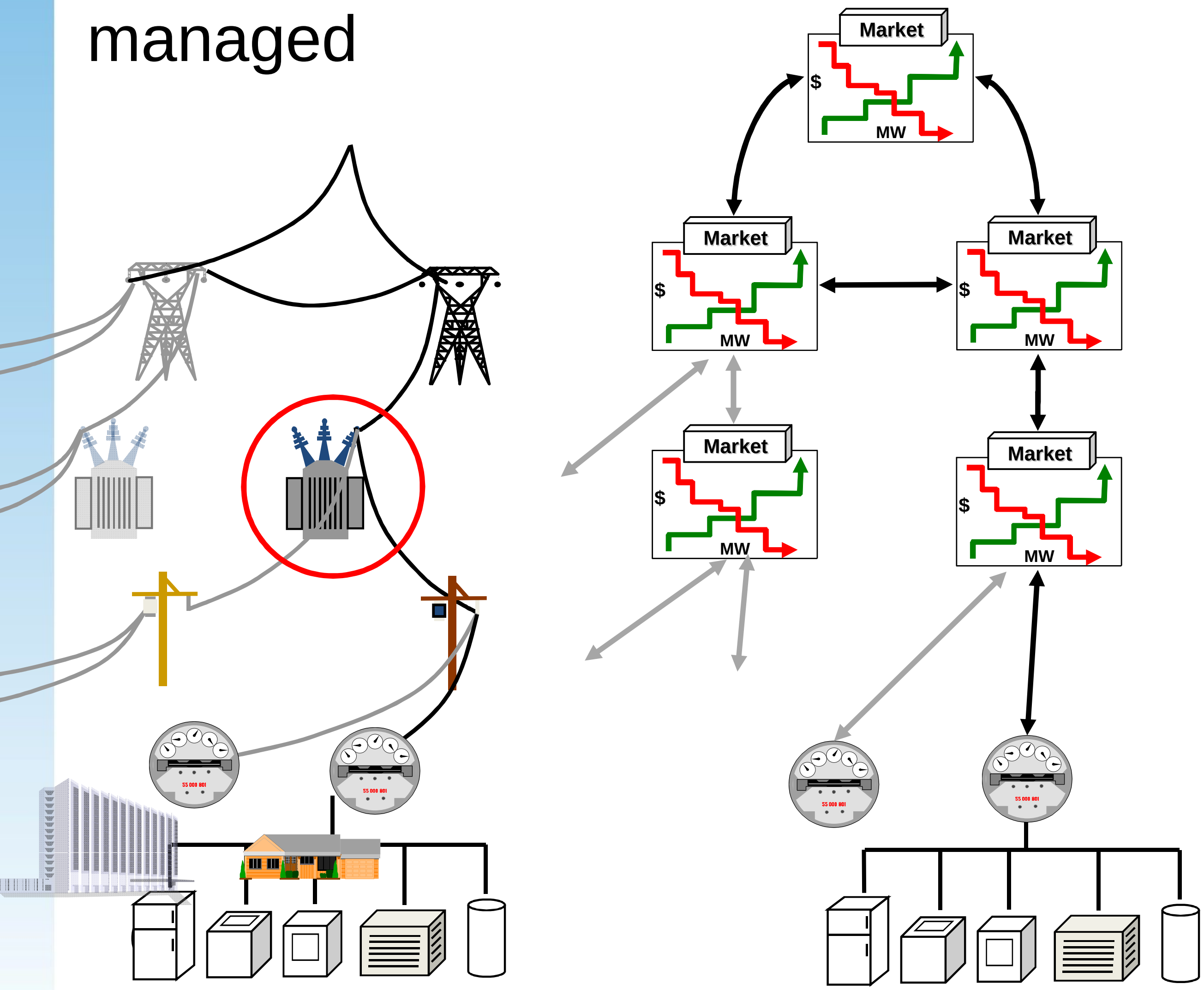
Two-way communication: Incentive and feedback signals

- The incentive signal is an *economic forecast* to electricity assets
- The feedback signal is a *consumption pattern* in response to the incentive.



Transactive Nodes Parallel the Grid Infrastructure

Node: any point in the grid where flow of load or supply can be managed



Node Functionality:

- Inform the nodes supplying it about future power needs – forecast
- “Offer” power to the nodes it supplies
- Resolve imbalances through a value - e.g, price discovery process
  - market clearing, for example
- Implement internal (local) value-responsive controls

Properties of Transactive Nodes

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- Use local conditions & global information to optimize operation of assets and collections of assets
- Indicate their response to the network node(s) serving them
  - to an *incentive signal* from the node(s) serving them
  - as a *feedback signal* forecasting their projected net flow of electricity (production, delivery, or consumption)
- Set incentive signal for nodes it serves to obtain the precise response from them, based on their feedback signals
- Response is voluntary (set by the node owner)
- Response is typically automated (and reflected in the feedback signal)

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INTEROPERATION WITH OTHER STANDARDS

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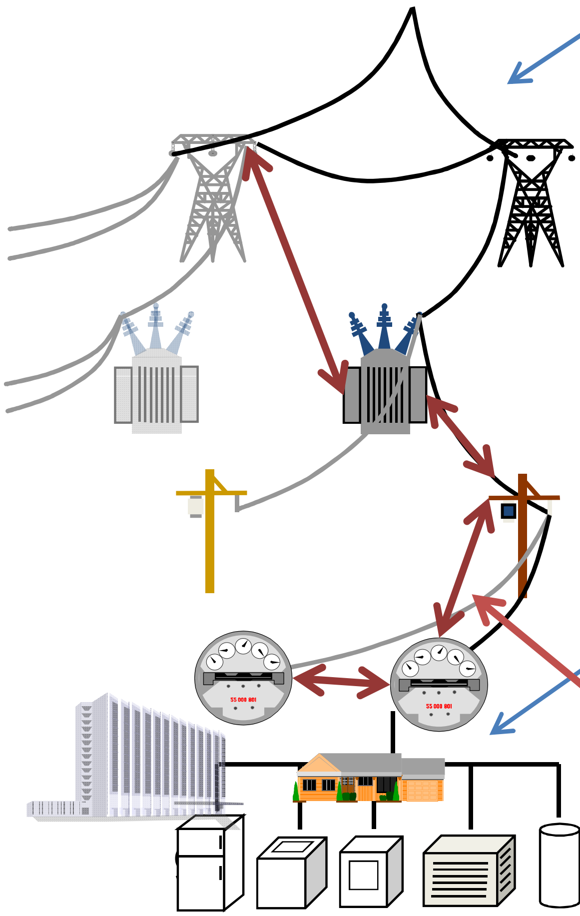
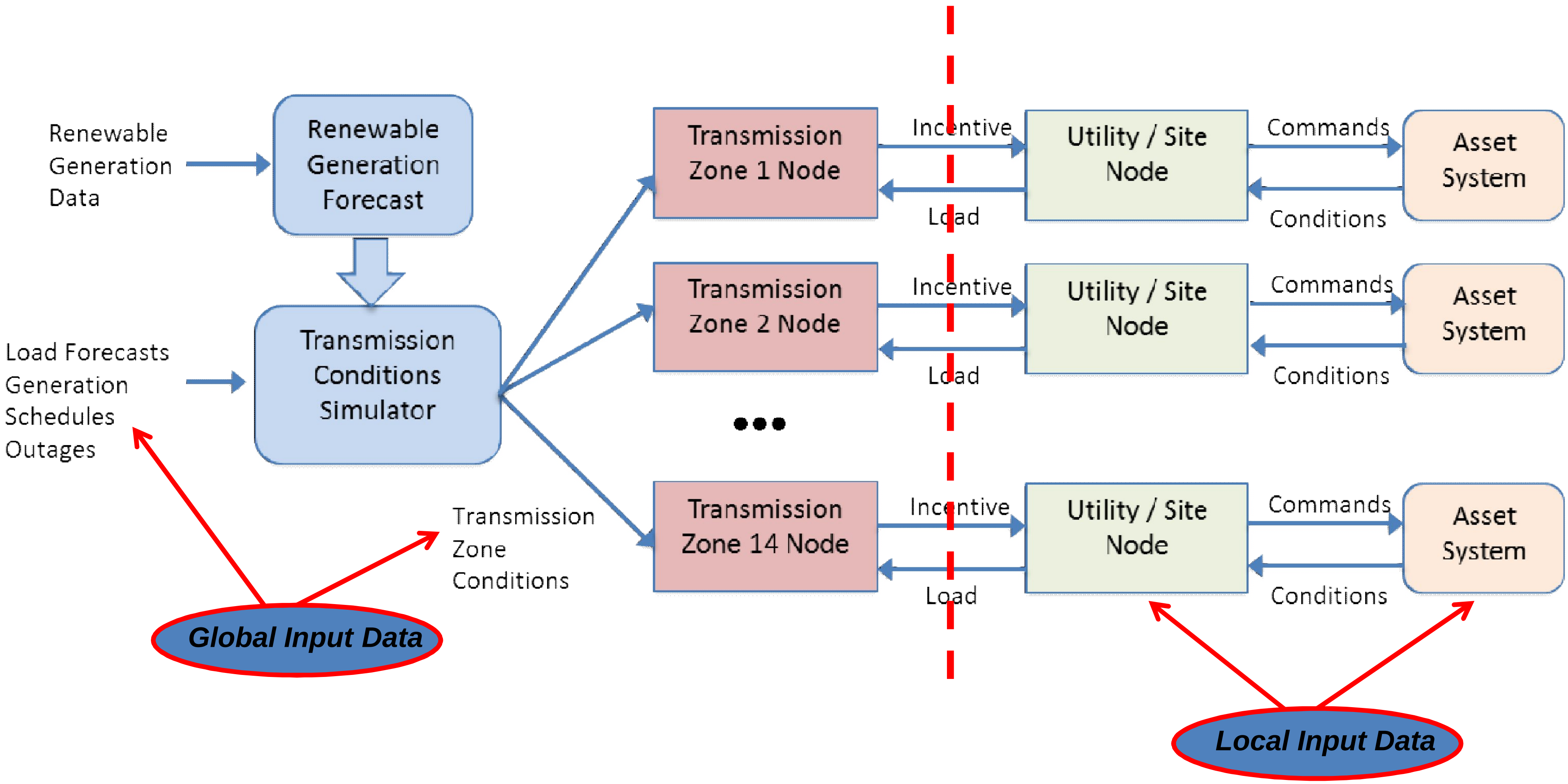
Information Interfaces



- Wide-Area Information
  - Generation schedules
  - Transmission constraints
  - Utility scale renewables
  - Regional cost/value/price
- Local information
  - Load forecast
  - DER forecast
  - Demand shaping capacity
  - Local cost/value/price
- Signaling between nodes

Input Data Interface Standards



Interfaces to Global Input Data

Potential Data Inputs

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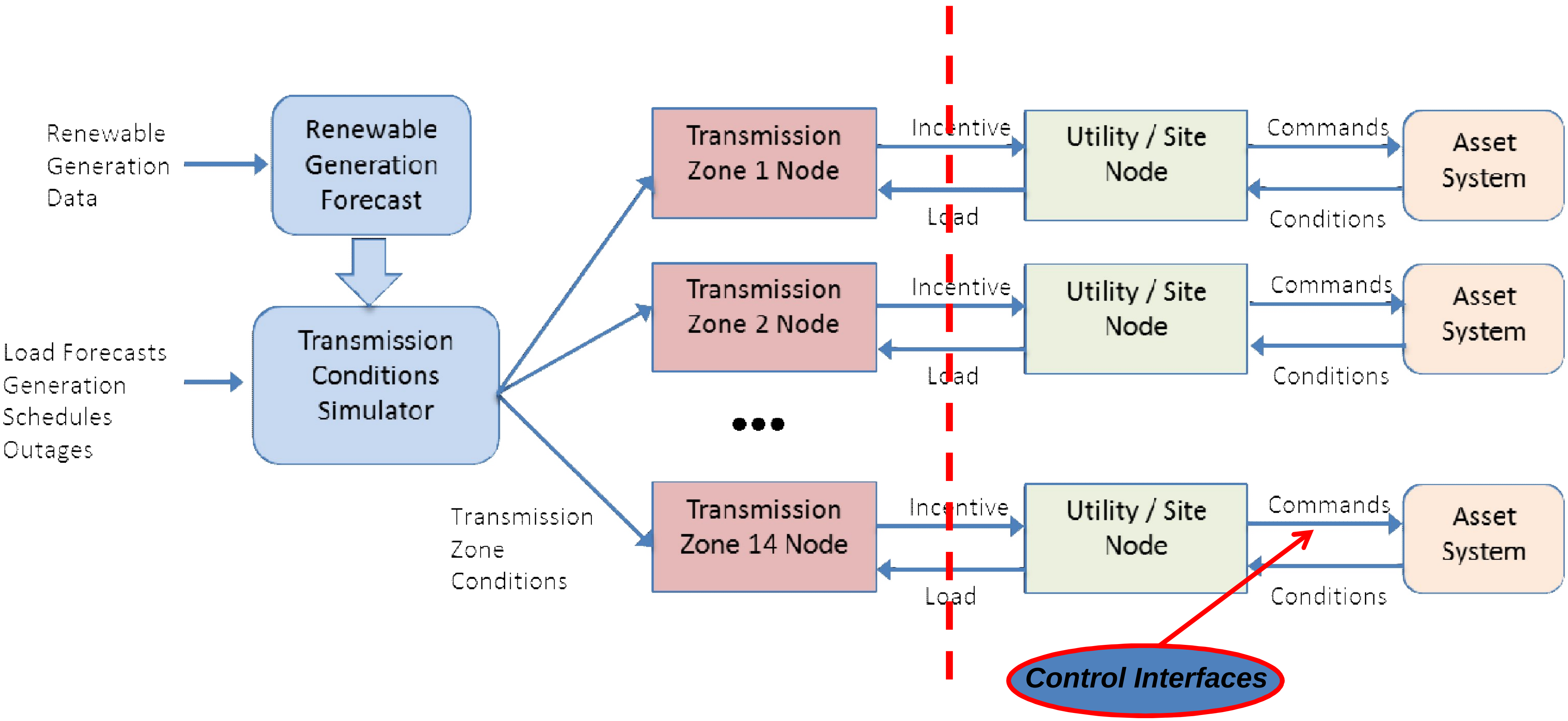
Global Level
- Forecasted Wind
- Hydro Schedule
- Price of Fuel
- Regional Load Forecasts
- Power Market Indices
- Generation Schedule
- Transmission Topology
- Availability of Wind
- Extra-Regional Transfers
- Interchange Schedule
- Solar Availability
- Solar Forecast
- Non-Power Constraints
- Available Transfer Capability
- Generation Outage Schedule
- Transmission Outage Schedule
- Transmission Schedule
- Station Control Error
- Area Control Area
- Power Tariffs
- Historical System Load Data

Local Level
- Local Node Measurement
- DER Forecast
- Current Local Weather
- Forecasted Local Weather
- Automated Metering
- Historic Local Load

Global Information Standards

- Examples:
  - ICCP (Inter-Control Center Protocol) TASE.2 IEC
  - EIDE (Energy Information Data Exchange)
  - METAR (aviation routine weather report)
  - Multispeak (proposed IEC 61968-14 mapping)
  - ISO 19115 (GIS meta-data)

Output Control Interface Standards

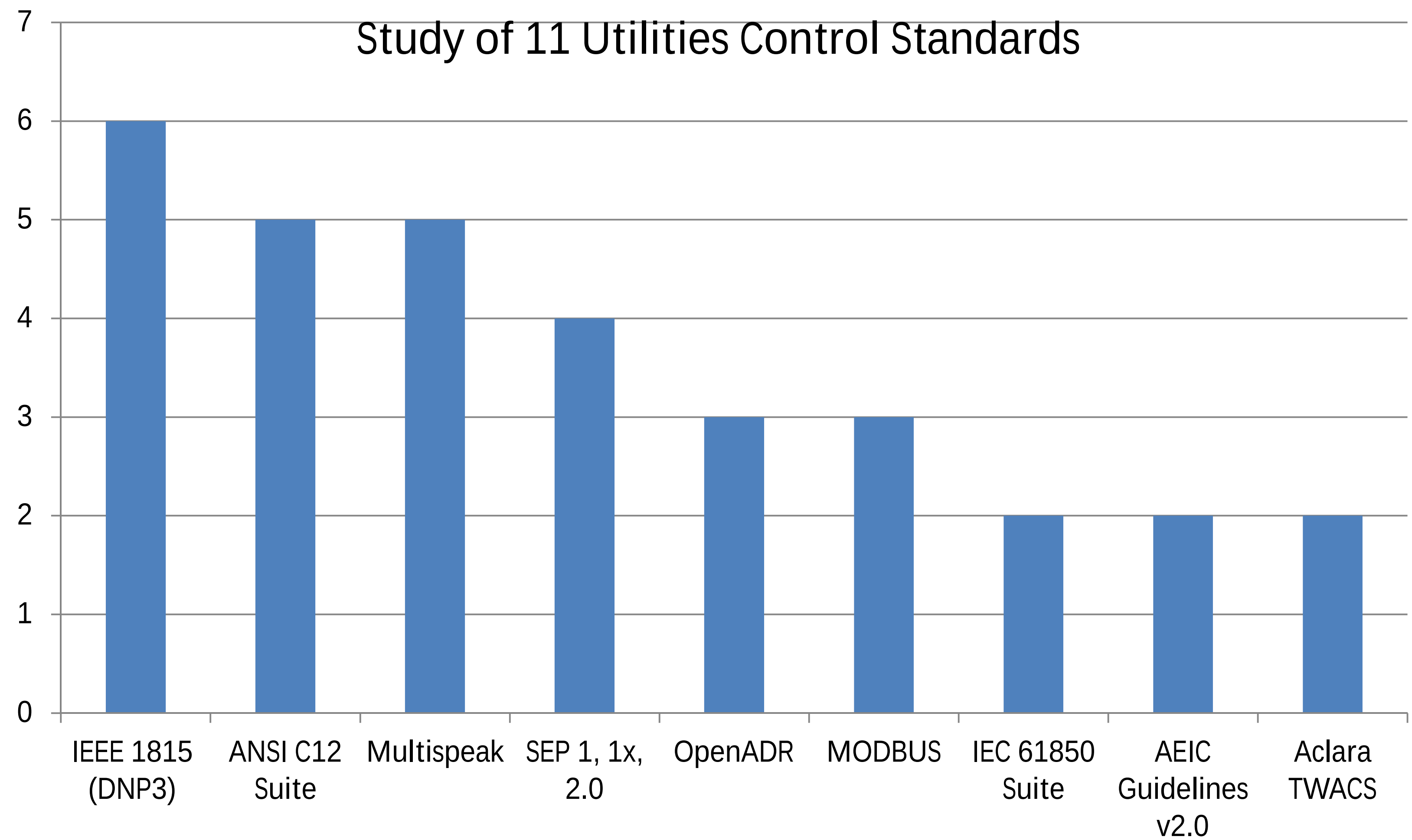


Control Output Interfaces

Local Transactive Assets Types

Transactive Asset Type
Distributed Generation
Distributed Storage
Consumer Usage Information Portal
Smart Meters/AMI
Smart Appliances
Smart Thermostat
DR Direct Load Control Module
PHEV/EV
Commercial/Industrial DR
Smart Transformers/Fault Indicators
IVVC, CVR, VO/ Voltage Regulators
Microgrid

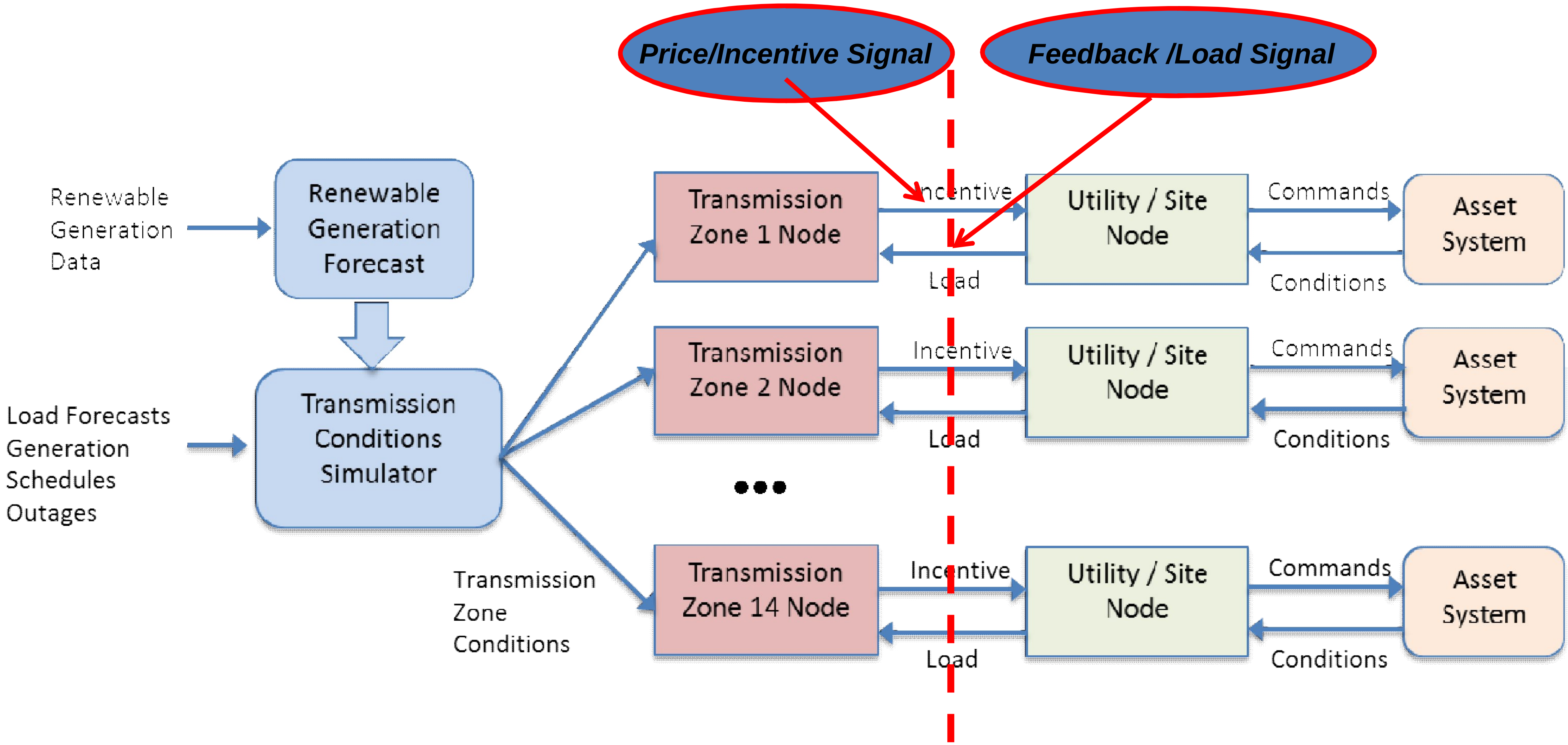
Control Standards Study



Emerging Control Standards

- For future Transactive Energy interface standards:
  - OpenADR Version 2
  - SEP Version 2
  - Green Button/ESPI
  - IEC CIM
  - IEC 61850
  - Others TBD

Wide-Area Information Flow



Transactive Signal Interfaces between Participants

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Signaling Standards Research

- Standards identified in the NIST Framework and Roadmap V1.0
- Expanded to include standards being considered for inclusion in the Roadmap and SGIP
- SGIP Priority Action Plans (PAPs), especially PAP 3 (price), PAP 4 (scheduling), and PAP 9 (DR, DER, markets)
- Determine if there were standards the Project should borrow from

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Signaling Standards

Requirement/ Interface	Standard	Comments
Incentive/Load Fields Syntax, Semantics	eMIX V1.0	Potential Signal Protocol
Incentive/Load Fields Syntax, Semantics	SEP 2.0	Potential Signal Protocol
Incentive/Load Fields Syntax, Semantics	ISO 18012	Interoperability Framework
Incentive/Load Fields Syntax, Semantics	ISO/IEC 15067-3	DR Application Interface Model
Incentive/Load Fields Syntax, Semantics	ISO/IEC 15045	Companion to 18012
Incentive/Load Fields Syntax, Semantics	IEC 61850	Potential Signal Protocol
Incentive/Load Fields Syntax, Semantics	CIM, 61970	Potential Signal Protocol
Identification of universal object ID Node description	CIM with 61850 identifiers.	Potential Signal Protocol
Signal interval Start Time	WS-Calendar	Potential Signal Protocol

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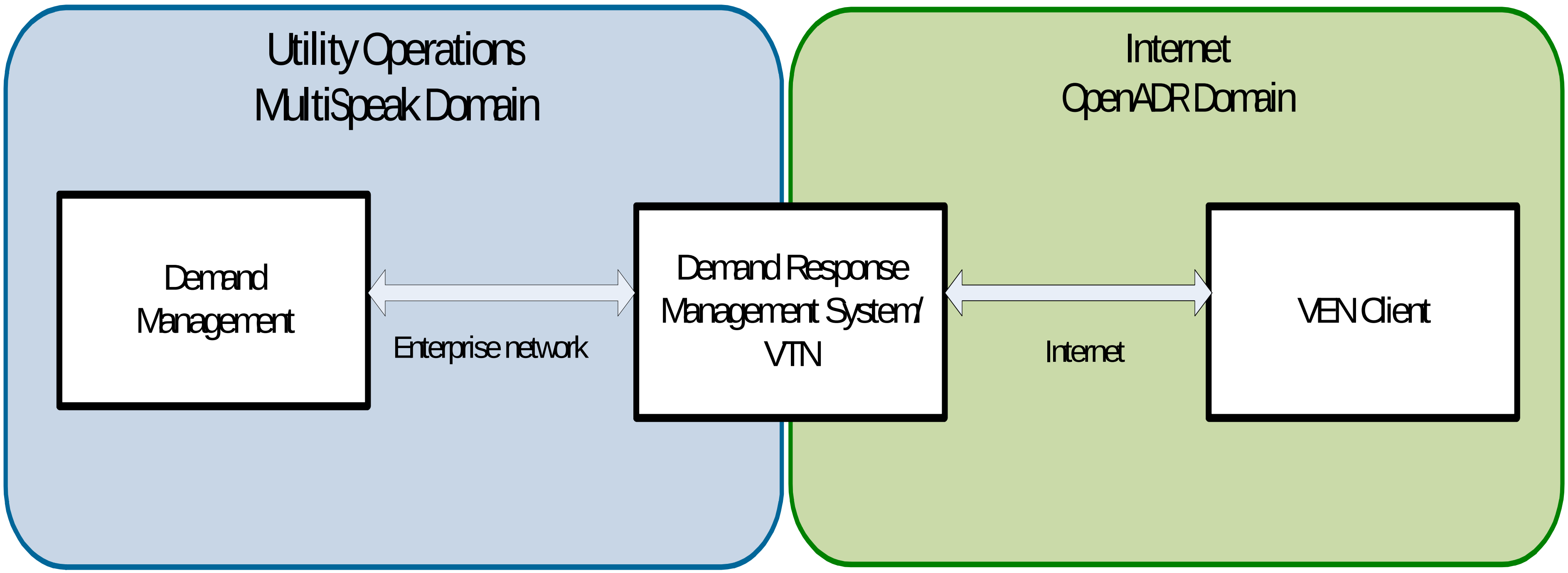
MAPPING METHODOLOGY

Methodology

- Start with business cases for interoperation of two standards – what information needs to be exchanged and why?
- Develop Use Cases specific to interaction
- Map data elements and functions between standards
- Develop adapter technology to implement
- Develop test tools to validate

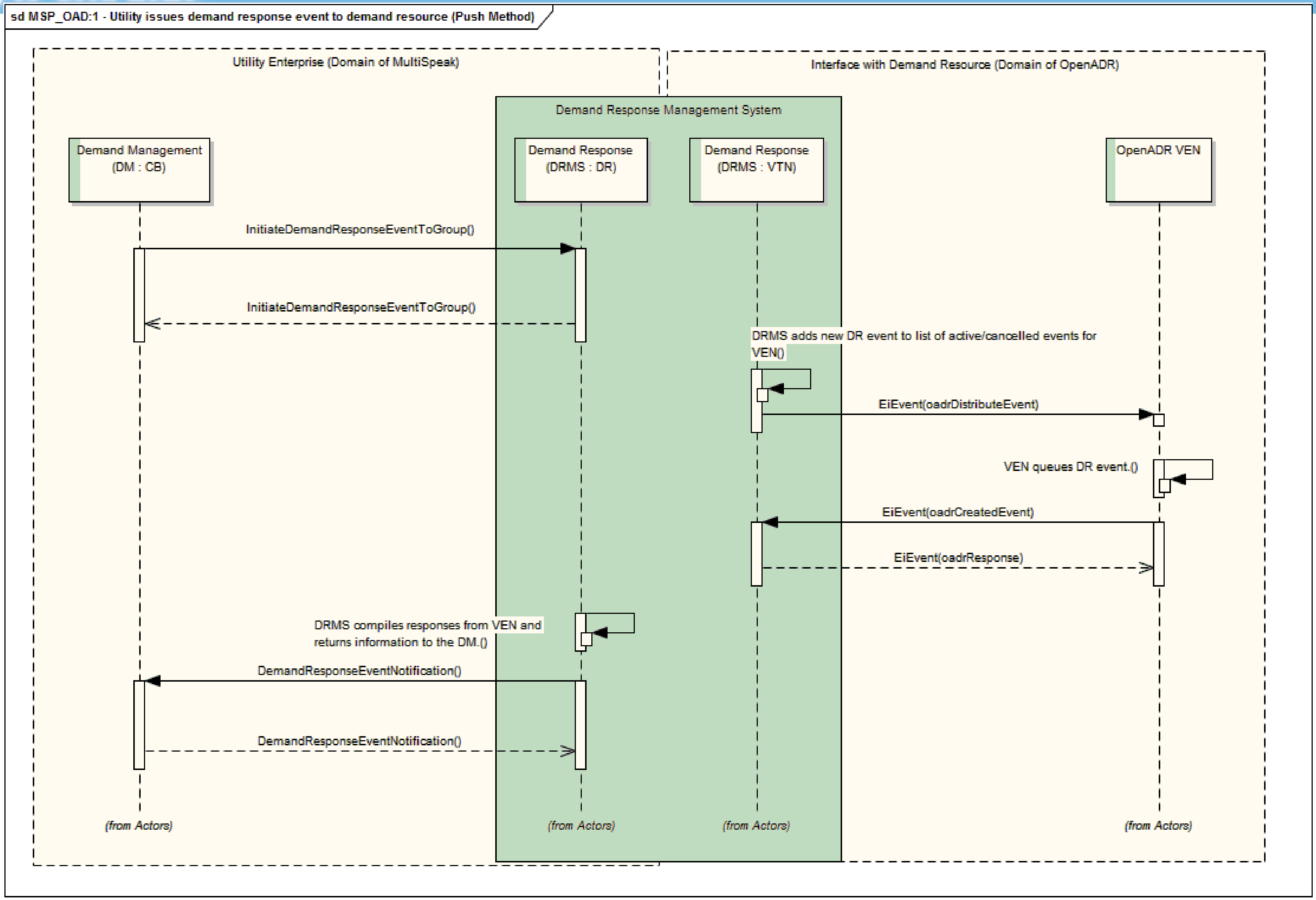
Example: MultiSpeak to OpenADR



Use Case Example

- *Utility manages demand response event to customer demand response resource(s).*
  - Utility issues demand response event to customer demand response resource(s) (PUSH Method)
  - Utility cancels active or future demand response event (PUSH Method)
  - Utility modifies demand response event (PUSH Method)
  - VEN requests list of active events (PULL model)

Example Sequence Diagram



Example Mapping Table

MultiSpeak Methods: Initiate/Cancel Message Object: demandResponseEvent		Mapping	OpenADR 2.0a Profile Object: oadrDistributeEvent.oadrEvent.eiEvent.eiActivePeriod	
Element	Description		Element	Description
<eventStartTime>	Start time for the DR event, if not specified, then the start time is now	Direct	<properties.dtstart>	Start time of the event
<eventDuration>	Duration of the DR event, if not specified, then the duration is forever	Direct	<properties.duration>	Duration of the event, if the attribute is 0, then the event goes forever
		NA	*<properties.tolerance.startbefore>*	This allows the definition of a random start time, and is ignored by VENs in 2.0a
<randomizeEventStart>	Apply a randomized dither to the start of an event (a Boolean value)	Derived: use a default value if the element is set to "true"	*<properties.tolerance.startafter>*	This allows definition of a random start time after the beginning of an event
		Derived: Default to 0	<properties.x-einotification.duration>	Length of time for notification of the event (possibly no functional effect in 2.0a)
		ExtGap2	*<properties.x-eiRampUp>*	Ramp up period and is used in 2.0a profile to determine when the event status transitions from "far" to "near"
		ExtGap2	*<properties.x-eiRecovery>*	Event recovery period
		NA	<components>	Placeholder to maintain schema conformance with Energy Interop

ESPI/Green Button and Transactive Energy

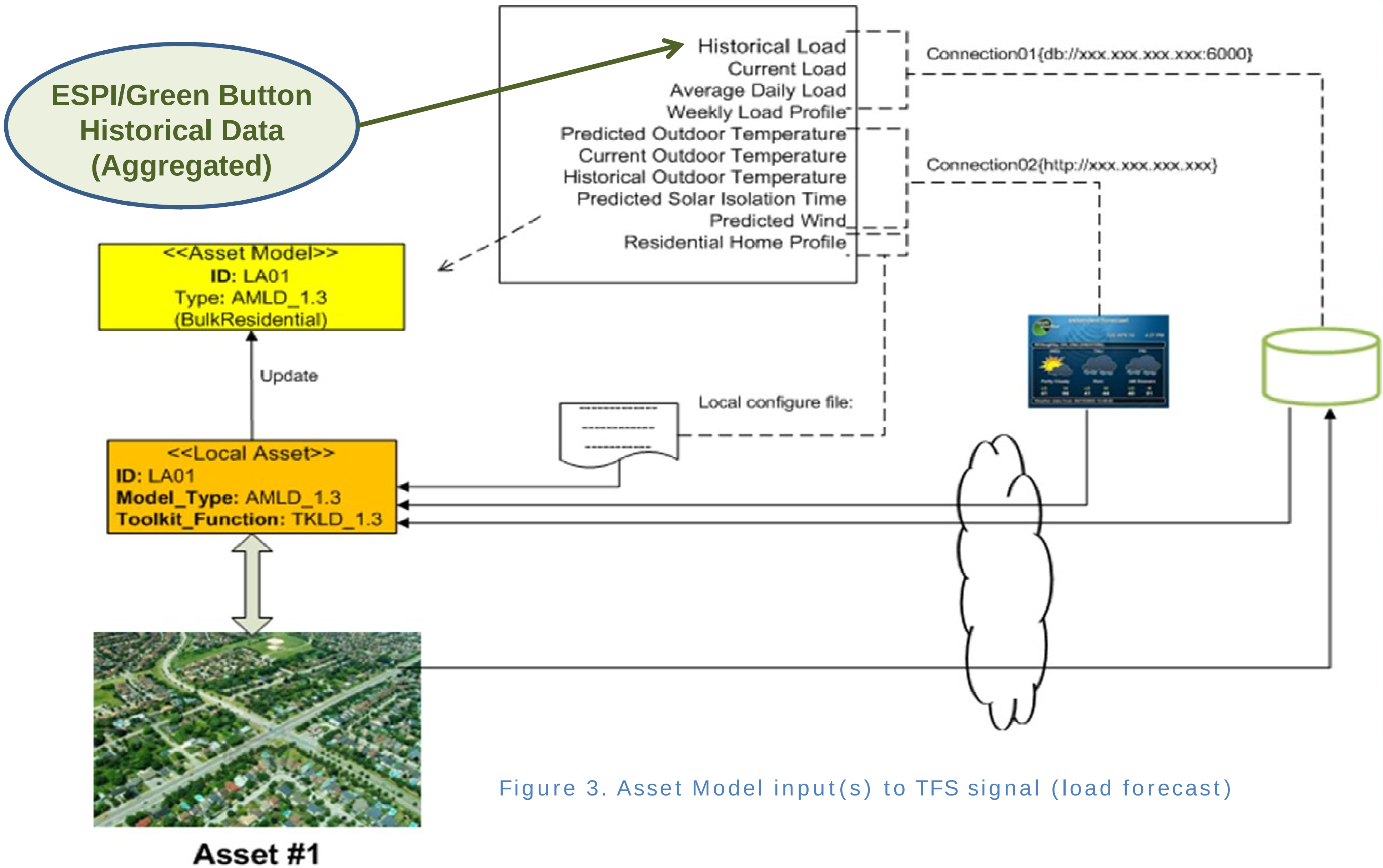


Figure 3. Asset Model input(s) to TFS signal (load forecast)

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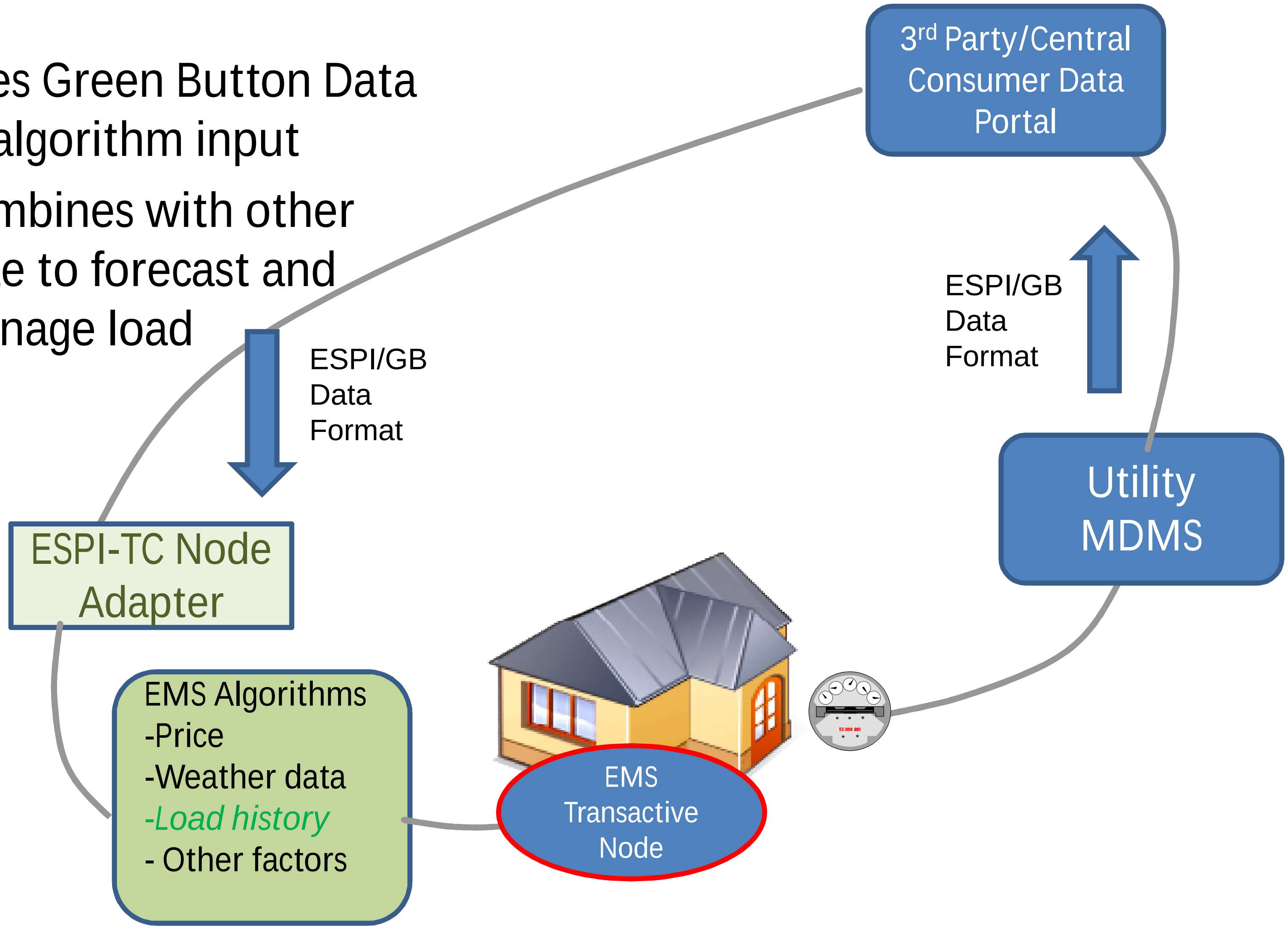
Transactive Energy to Green Button Use Case

- Home EMS Transactive Node
  - Uses Green Button Data as algorithm input
  - Combines with other date to forecast and manage load



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SUMMARY

In Summary

- Transactive Energy requires interoperation with numerous standard interfaces
- An initial set of interoperability mappings has been identified based on research
- A mapping methodology has been developed