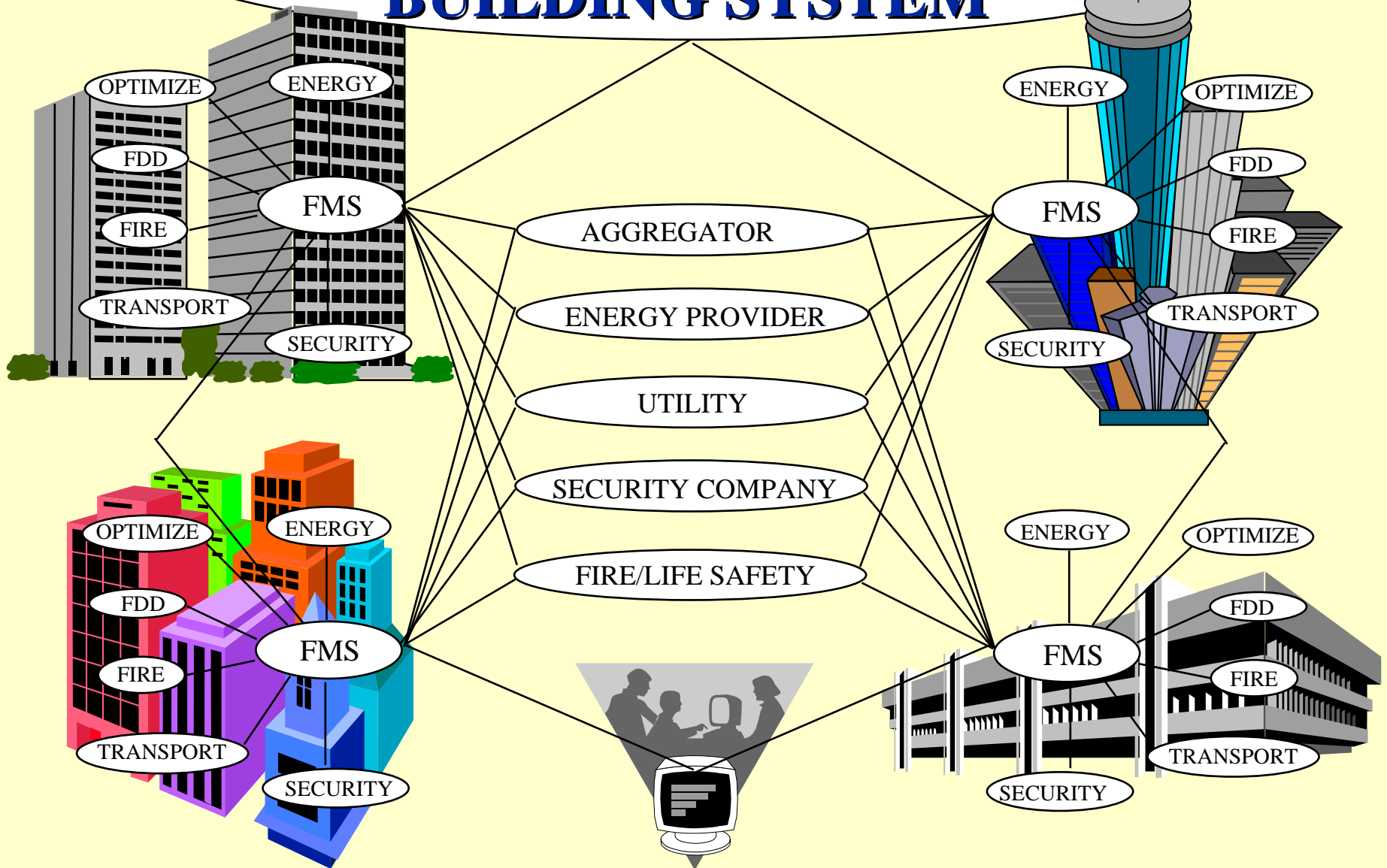# Utility communications with BACnet commercial building for price peak response

David Holmberg
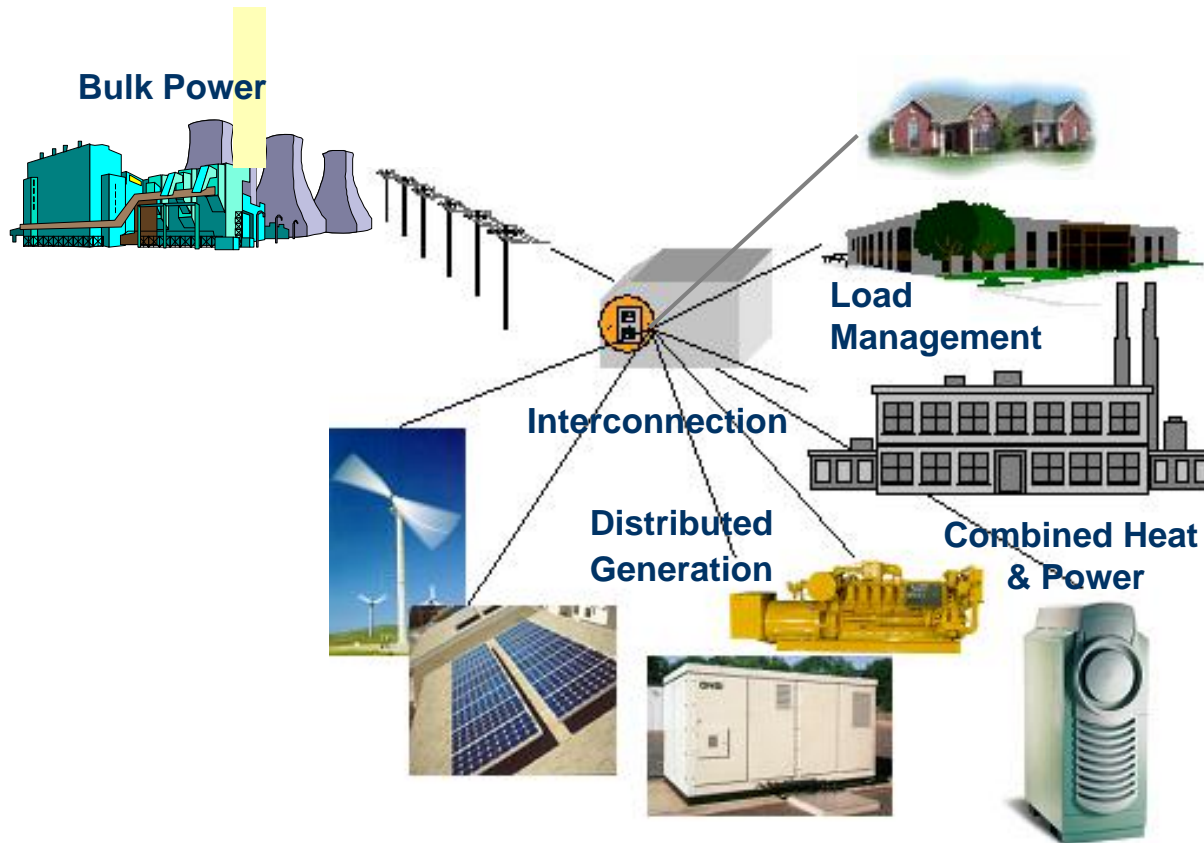
NIST Building and Fire Research Laboratory

THE CYBERNETIC BUILDING SYSTEM

OPTIMIZE
ENERGY
FDD
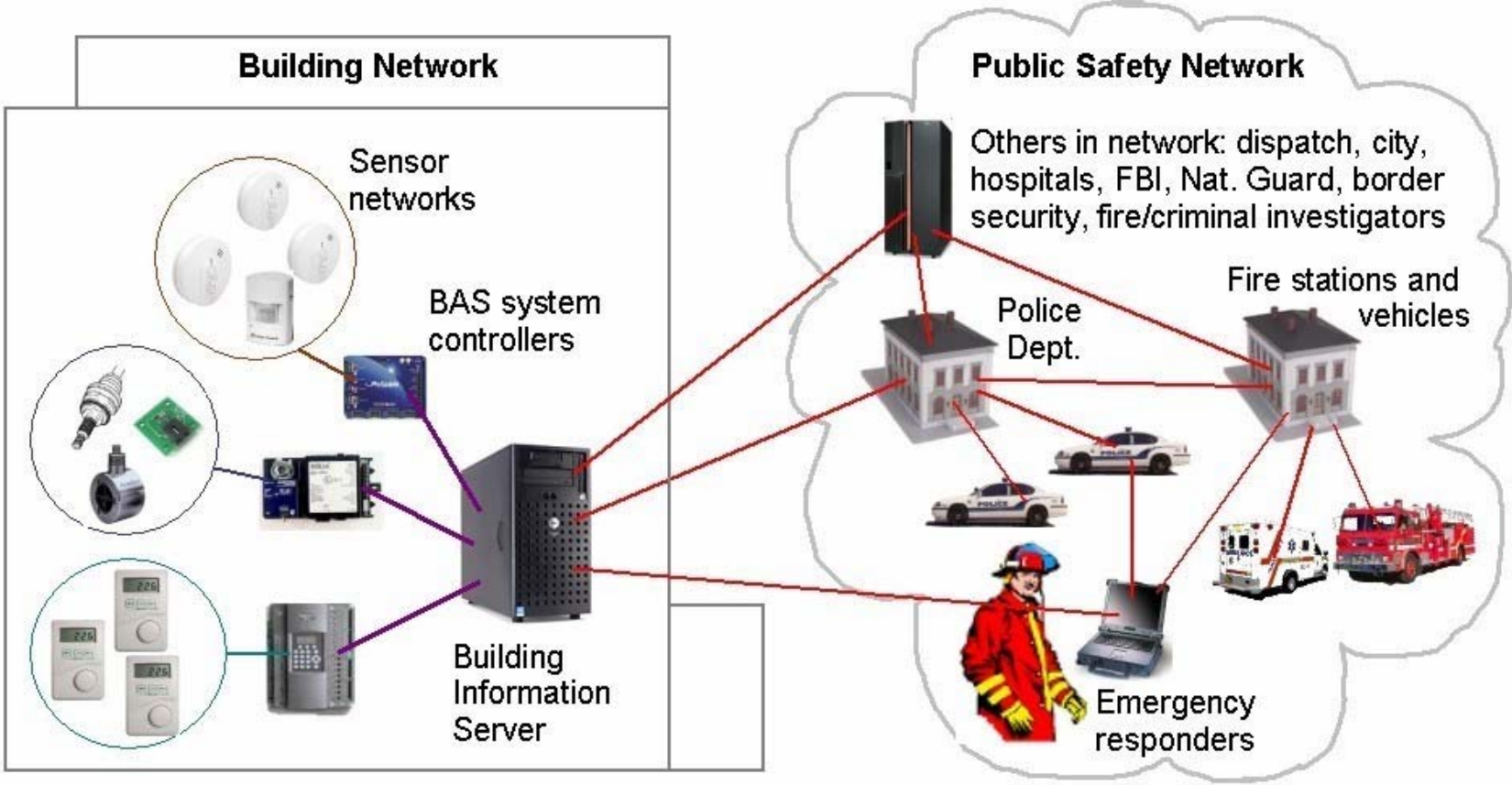FMS
FIRE
TRANSPORT
SECURITY

ENERGY
OPTIMIZE
FDD
FMS
FIRE
TRANSPORT
SECURITY

AGGREGATOR

ENERGY PROVIDER

UTILITY

SECURITY COMPANY

FIRE/LIFE SAFETY

OPTIMIZE
ENERGY
FDD
FMS
FIRE
TRANSPORT
SECURITY

ENERGY
OPTIMIZE
FDD
FMS
FIRE
TRANSPORT
SECURITY

Power grid view from utility to customer…
How is the load managed?

Bulk Power

Load Management

Interconnection

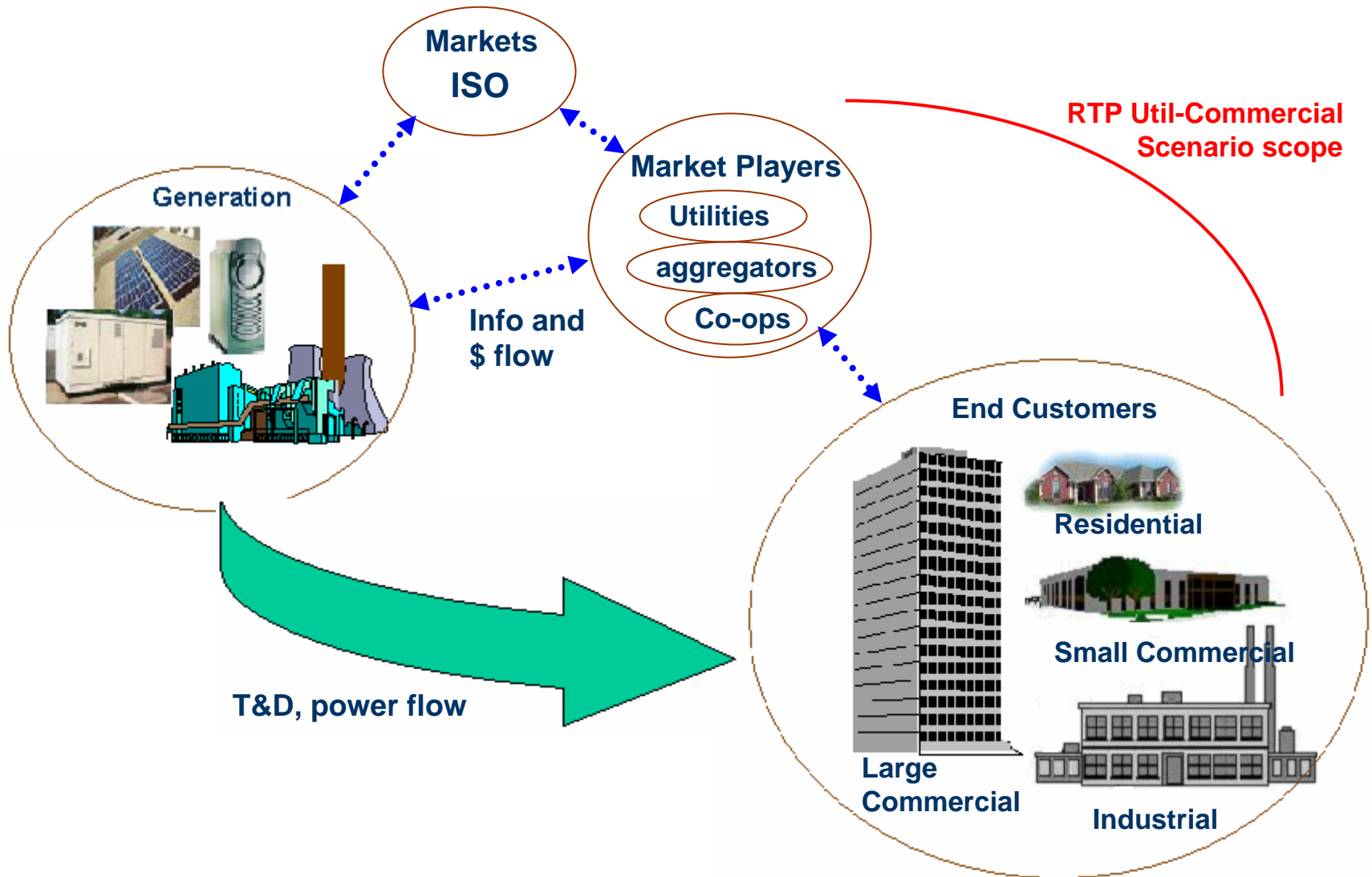**Distributed Generation**

Combined Heat & Power

(figure borrowed from Eric Lightner's 2003 presentation on DOE Electric Distribution Transformation program)

Many control system networks connected to building information server gateway to external service provider (the public safety view)

Info grid from utility to customer…
(anyone have a better version of this?)

Markets ISO

Market Players
- Utilities
- aggregators
- Co-ops

RTP Util-Commercial Scenario scope

Generation

Info and $ flow

End Customers
- Residential
- Small Commercial
- Large Commercial
- Industrial

T&D, power flow

The Large Commercial customer

- Significant power consumer—with ability to trim 5% or 10% of load.
- Significant building controls intelligence
- Previous DR efforts hampered by need for custom interface to each customer
- What is needed is standard messages and standard EMCS interface
  - now very possible.

BACnet for standard building interface

- Worldwide protocol (ANSI/ASHRAE and ISO standard) for building automation system control, providing interoperable:
  - Data sharing
  - Alarm and event management
  - Trending
  - Scheduling
  - Remote device and network management
- Currently has web services interface
- Has Load Control object and everything needed for energy management

Scenario details--DR in a large commercial building

- The scenario: Large commercial facility gets day-ahead notice of estimated RTP peak going over trigger level from 2-6pm (or utility posts a CPP event with start time of 2pm).
- Messages are communicated via web services to the EMCS of a commercial customer, using standard message syntax.
- EMCS examines facility use schedules and proceeds to schedule:
  - Pre-peak:
    - Pre-cooling of some building spaces
    - Lowering cooling of chilled water temperatures by 1 degree
    - Half hour preceding event, the EMCS starts warm-up of generators and staged shut-down procedures for some building equipment
  - At the start time of the CPP event:
    - One of three chillers is shut down, with raised chilled water temperature set point
    - Unnecessary motor loads (such as the fountain pumps and escalators) are off
    - Temperature setback of lower-sensitivity building thermostats
    - Backup generator is feeding load to the grid

Test Drive of Architectural Framework

- I had to think deeply in an iterative process. Led to new insights.
- My simple understanding of the the flow of the framework:
  - Politics/regulations help inform and support objectives
  - Business objectives guide business processes and procedures.
  - Business procedures (how we're going to do it) scopes technical solutions.
  - The informational elements represent the business folks understanding each other—sharing business goals and reaching a deeper understanding of semantics.
  - Technical folks work out the details within the business scope.
- I have put that standards work under the "Business Procedures" section. I have proposed some category element name changes (such as from "business" to "organization")
- I found the "Informational" layers seemed to duplicate elements I had above in the Organizational layers or below in the Technical layers. It wasn't clear to me who needed information that didn't already have it.

Commercial Building acts on RTP and CPP events

Interoperability Category	Tools, Systems, Key Actors	Examples of interoperation across organizational boundaries where agreements must be reached
ORGANIZATIONAL		
Economic/Regulatory Policy Political and economic objectives as embodied in policy and regulation	Fed and state gov't Local gov't, PUCs Organizations (LEEDS, ASHRAE) ISO	•Gov't bodies set policy for utility rate offerings. EG FERC encourages ISOs to build up markets for DR. NE ISO responds with real time market. •State gov'ts mandate DR goals. E.g., PA requires all gov't facilities to cut load, participate in load shedding plans, and implement DR strategies. •GSA specs BACnet in federal facilities •Independent orgs like LEEDS and ASHRAE make efforts toward sustainable buildings that can do DR. Lobby gov't bodies. Work on standards.

Commercial Building acts on RTP and CPP events

Interoperability Category	Tools, Systems, Key Actors	Examples of interoperation across organizational boundaries where agreements must be reached
ORGANIZATIONAL		
Business Objectives Strategic and tactical objectives shared between businesses Strategic object: Save energy and money with DR, DG Tactical object: communicate utility needs to customers who can act. Specifically: communicate RTP to the Large Commercial facility owner (but we need to keep other customers and services in scope)	Utilities Market Facility mgrs BOMA Building control system vendors ASHRAE	Utility community works with building community through Gridwise to understand needs of commercial building owners and potential DR response of buildings. Building control system vendors work to develop BACnet standard to allow DR response to utility signals and a standard device-level load shed interface. Gridwise reaches out to BOMA to promote RTP and other DR programs and the benefit to building owners to participate and how to do that. RTP to large commercial customers is really a subset of a wide array of DR customer programs. Somewhere upstream there needs to be a discussion of bigger utility-customer program direction: what is the plan for implementing which services? How does this particular scenario fit into the bigger program objectives?

Commercial Building acts on RTP and CPP events

Interoperability Category	Tools, Systems, Key Actors	Examples of interoperation across organizational boundaries where agreements must be reached
ORGANIZATIONAL		

Business Procedures
 	
Alignment between Objectives, Operational Business Processes and Procedures
 	
Stakeholder community members need to realign business with objectives.
Stakeholders need to be clear on objectives, and act on them.
And business procedures need to align with processes.
Business processes:
    what we are doing.
Business procedures:
    how we are doing it.
So, how do we communicate utility info to customer?
What are the roles of standards bodies and Gridwise?
	Utility community
	
	Facility Management community
	
	Stakeholders on path from generator to customer
		Utilities need to plan their rate structures to include RTP rates for commercial customers and standard implementation.
		Stakeholders get together and agree that:
		    A utility-customer contract is in place that specifies: account IDs, passwords/keys, rate class, web server address, etc.
		    Utility distributes RTP data using a web service interface with encryption.
		    RTP message data includes RTP hourly schedule (with specified units and formats), plus account info and timestamps.
		So, at the business level, stakeholders need to agree on the specific message series and data that will be exchanged.
		Utility stakeholders agree on high-level path for messages from generators through aggregators to end customers.
		Gridwise and BACnet take leadership in utility and building communities to see that:
		    Standards are developed, promulgated, and promoted.
		    Utility and building communities recognize and accept **community business objectives**
		Utility standards body sets up a process for maintenance of the customer RTP web services standard with BACnet liaison.

Commercial Building acts on RTP and CPP events

Interoperability Category	Tools, Systems, Key Actors	Examples of interoperation across organizational boundaries where agreements must be reached
INFORMATIONAL		
Business Context Awareness of the business knowledge related to a specific interaction Both sides of the ineroperability coin need to understand the context of RTP communications to large facility customers. What do end-users need to understand about utility business and vice versa? How will this solution benefit them?	Stakeholder organizations on building and utility sides Standards bodies Gridwise	Building community and utility community meet to understand business interests. For example: - Utility wants all account and price data information to remain confidential, therefore encryption is required. - Hourly rates with day ahead estimates gives building owners sufficient time to plan DR. - Utility requires response to ensure customer non-repudiation. (For CPP case—the utility reads the meter to judge compliance, but does the customer get access to what the utility thinks the meter says?) Gridwise puts article in some facility management publication to explain different utility services and why RTP is best choice to roll out first to serve needs of utilities and large commercial customers.

Commercial Building acts on RTP and CPP events

Interoperability Category	Tools, Systems, Key Actors	Examples of interoperation across organizational boundaries where agreements must be reached
INFORMATIONAL		
Semantic Understanding Understanding of concepts contained in the message data structures Both sides of the ineroperability coin need to understand the meaning of concepts: What is RTP? What is contained in "account information" (e.g., what is an appropriate Account_ID)?	Stakeholder organizations on building and utility sides	Building community and utility community share their perspectives on what RTP messages should be. For example: Utility sends price data that includes today and tomorrow's hourly rates with prices fixed one hour ahead and future prices estimated, total of 48 hours of prices. RTP message account information includes utility ID and rate program ID and customer ID and customer password, along with timestamp, all for authentication Response repeats back RTP data and timestamp. I come to this meeting to share from the facility manager perspective.

Commercial Building acts on RTP and CPP events

Interoperability Category	Tools, Systems, Key Actors	Examples of interoperation across organizational boundaries where agreements must be reached
TECHNICAL		
Syntactic Interoperability Understanding of data structure of messages exchanged between systems Who needs to know and agree on the nitty gritty of the messages? The application layer	BACnet XML and Utility Interaction working groups. Utility information standards body such as IEC 61968	•Technical folks flesh out the specific message details (fields, types, units, structures) •Perhaps there are messages upstream of the utility data center (on the utility side) needed to support the RTP service, and which need to be addressed. •BACnet committee works out standard for communicating load shed details to devices on the building networks. •There may be non-BACnet devices on the network that need gateways to understand load shed information.

Commercial Building acts on RTP and CPP events

Interoperability Category	Tools, Systems, Key Actors	Examples of interoperation across organizational boundaries where agreements must be reached
TECHNICAL		

Network Interoperability (M2M Architecture?) Mechanism to exchange messages between multiple systems across a variety of networks
 	
The software system for M2M communications.
 	
For traditional utility world comms this might be IEC 61850.
 	
For BAS it could be BACnet. In between, maybe web services.
	Technical committees to iron out architectural details within business directives	• Web services interface to utility needs standardized:
		   o SOAP messages
		   o XML details
		   o Security requirements
		• Alternatively, the utility may opt for a simpler interface (such as used for the PIER Auto-DR project) to communicate CPP events. The utility sends a signal to a relay that the EMCS reads.
		• Business decisions drive this component: what architecture is already installed? What other existing investments? What experience? What architecture best meets business objectives?

Commercial Building acts on RTP and CPP events

Interoperability Category	Tools, Systems, Key Actors	Examples of interoperation across organizational boundaries where agreements must be reached
TECHNICAL		
Basic Connectivity (Network Interoperability?) **Mechanism to establish physical and logical connections between systems** **Everything below the application layer: presentation, transport, network, data link, physical**	Technical committees	EMCS to Utility data connection could have network layer issues depending on whether the connection is made across the Internet or some proprietary utility network/ phy layer (e.g., radio) connection. Security connections will depend on network architecture. Web services across the Internet might be much easier than security associations required for a customer to join a private utility network at the meter.

Test Drive of Architectural Framework

- Thoughts on applying the framework:
  - The utility and building communities need to work together to understand the business context and technical scope for DR service interaction;
  - We need to fit the RTP scenario into a larger space—all possible energy saving and grid stabilizing utility-customer services, with a wholistic plan for what services should be implemented when and by whom. I am aware of the AMI use case collection that should paint the whole picture. Who is addressing the plan for moving forward?
  - We need leadership: in selling the vision (and required actions of individual companies) to different end-users; at the interface to governments; to direct required action in different standards bodies.
  - And, of course, we need to work together to agree on RTP messages, details, and the network architecture linking utility to customer EMCS.