



Demand Response Research Center and Open Automated Demand Response

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Presentation to the State Energy Advisory Board

Demand Response Research Center
Building Technologies Dept.
Lawrence Berkeley National Laboratory

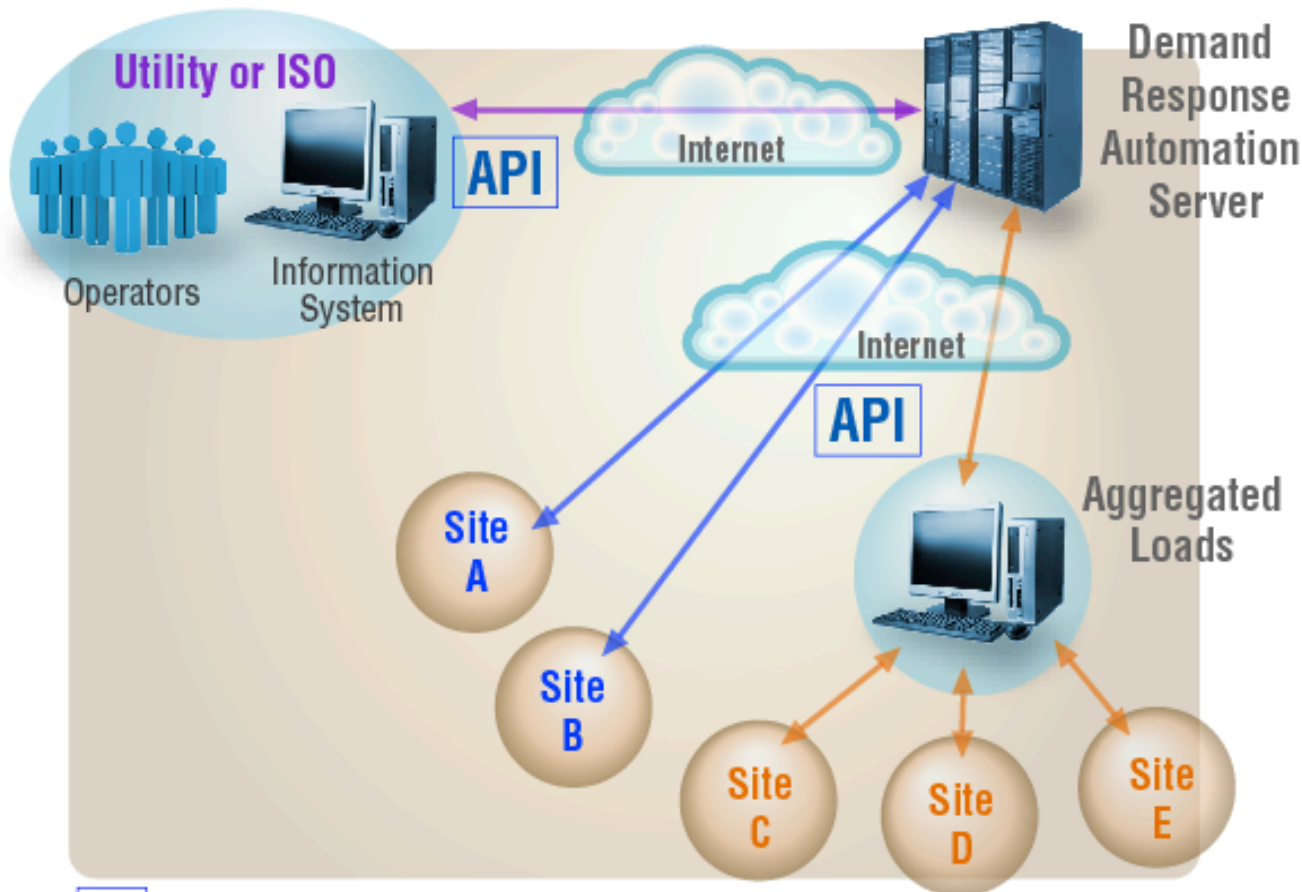
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Scope of DR Research Center

Sponsored by CEC, PG&E, SCE, SD&GE, DOE, BPA, NYSERDA, NRCANADA, SMUD,

- **Energy Systems Integration and Strategic Issues**
 - *Communications Infrastructures*
 - Grid Integration and Renewables
 - Market Design from Price Response and Ancillary Services
- **Buildings**
 - *Automation, Communications and Control*
 - *End-Use Control Strategies and Models*
 - Simulation Tools, Field Studies, Deployment and Training
 - Behavior Response
- **Industry**
 - Automation, End-Uses and Controls

OpenADR is a NIST Smart Grid Standard: Open Automated Demand Response



Signaling- continuous, 2-way, secure messaging system for dynamic prices, emergency and reliability signals. One-way applications are under development

Client-server architecture - uses open interfaces to allow interoperability with publish and subscribe systems

Current system - uses [internet](#) available at most large facilities or broadcasting points.

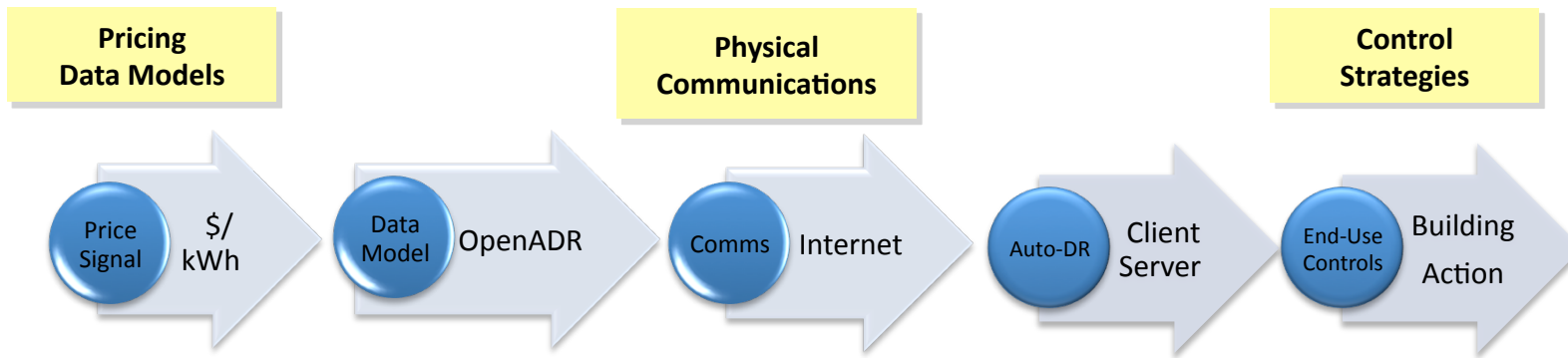
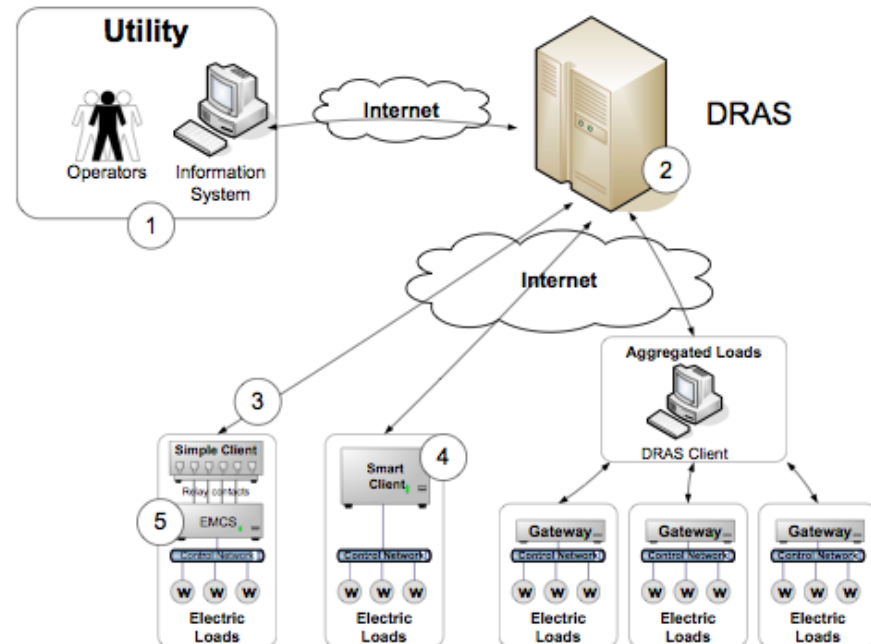
Hardware retrofit or embedded software - many clients fully implemented with existing XML software

OpenADR Technology Concepts

- **2002**- Initial Research Concept
- **April 2009** – OpenADR Spec Published
- **May 2009** - one of 1st 16 NIST Smart Grid Standards
- **2010** – OpenADR in over 250 facilities in California, over 150 MW planned

Elements -

- 1 Utility System**
- 2 DR Automation Server**
- 3 Two Way Signals to Facility**
- 4 Facility Controls**
- 5 Client Acknowledges Signal**

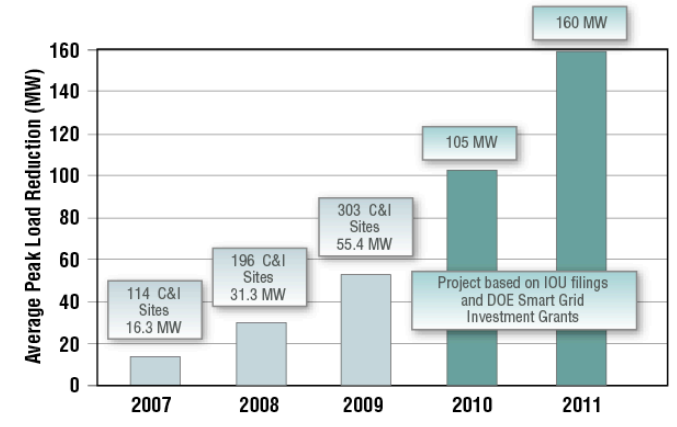
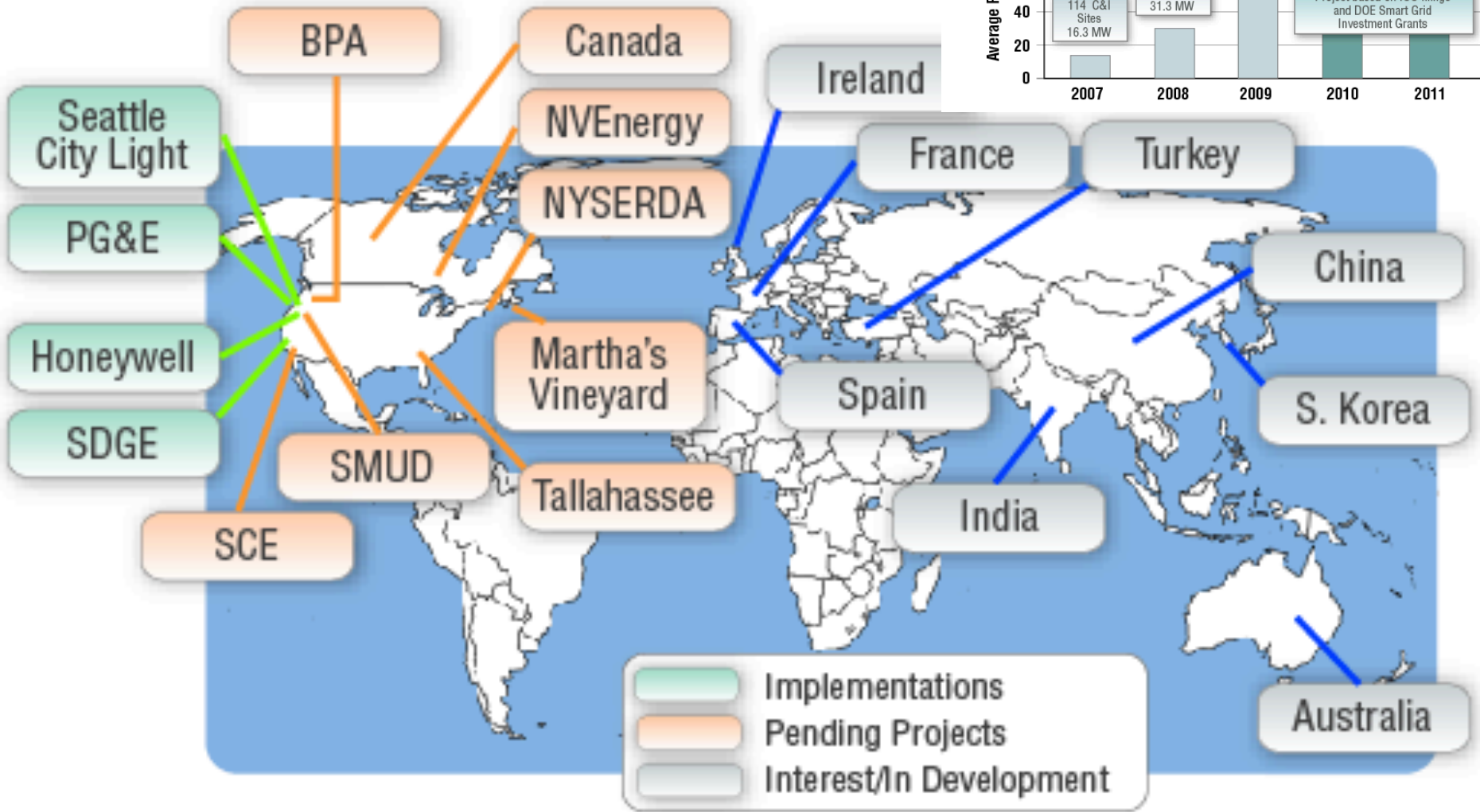


Over 50 Vendors Have OpenADR Client Over 350 Commercial and Industrial Facilities

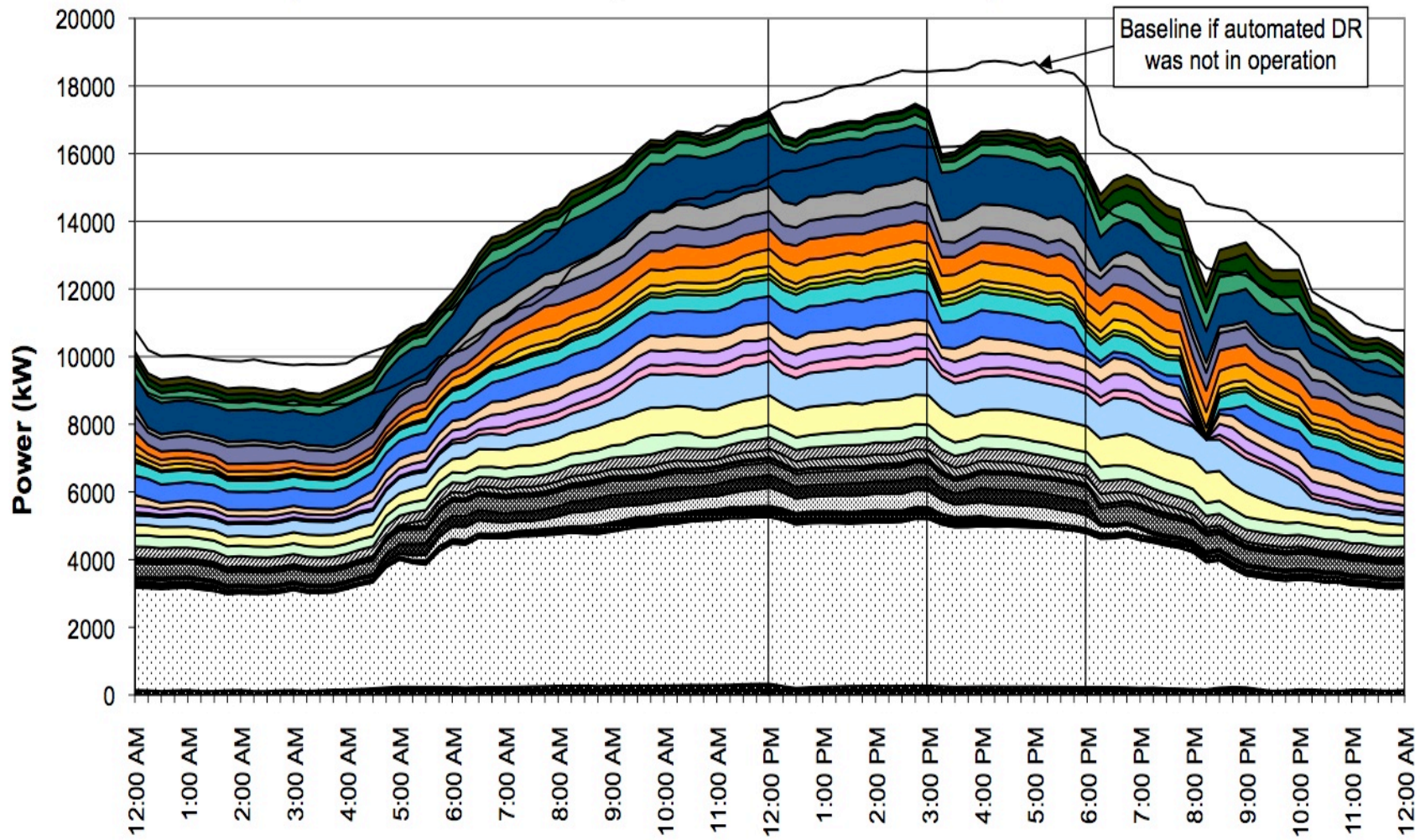
Akuacom OpenADR Client Development Program



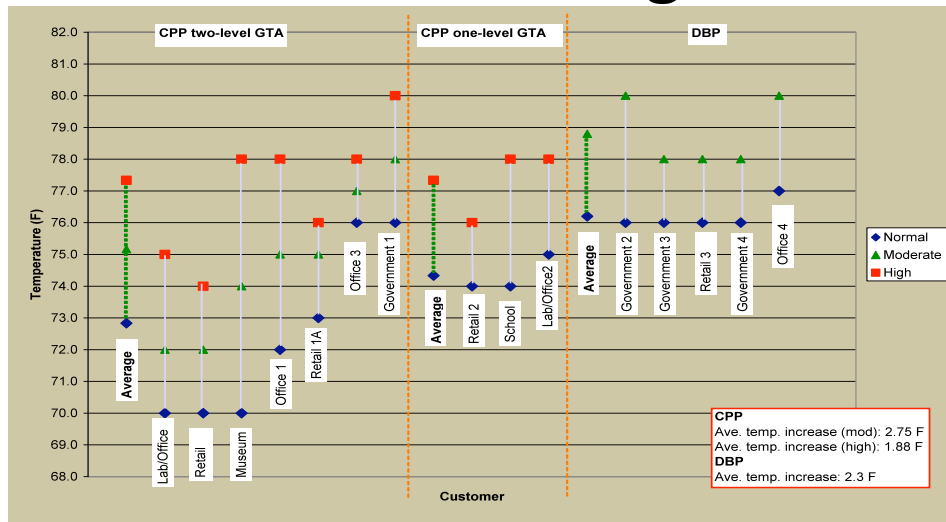
OpenADR Deployment



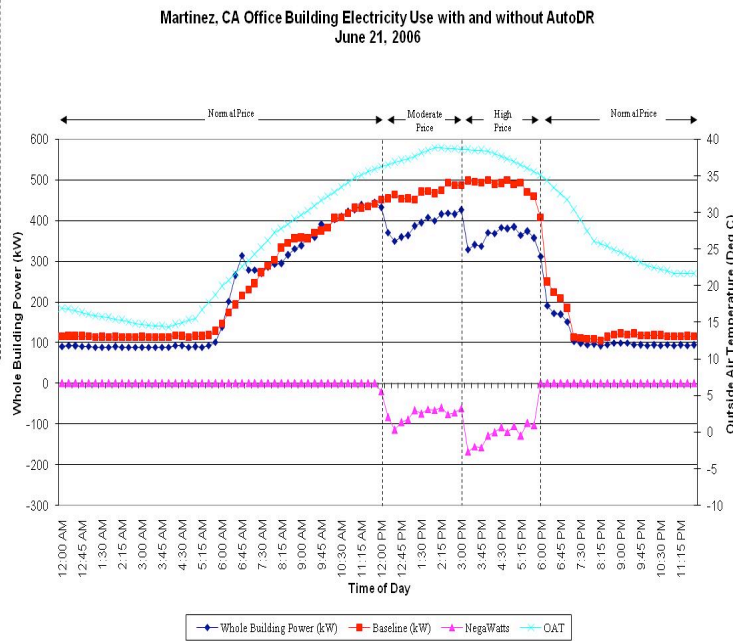
Aggregate Customer Loads for the Automated Critical Peak Pricing Event on 7/9/2008 Fully Automated Demand Response Reduce Peak Demand by 2.2 MW



DR Control Strategies Evaluated in Previous Research

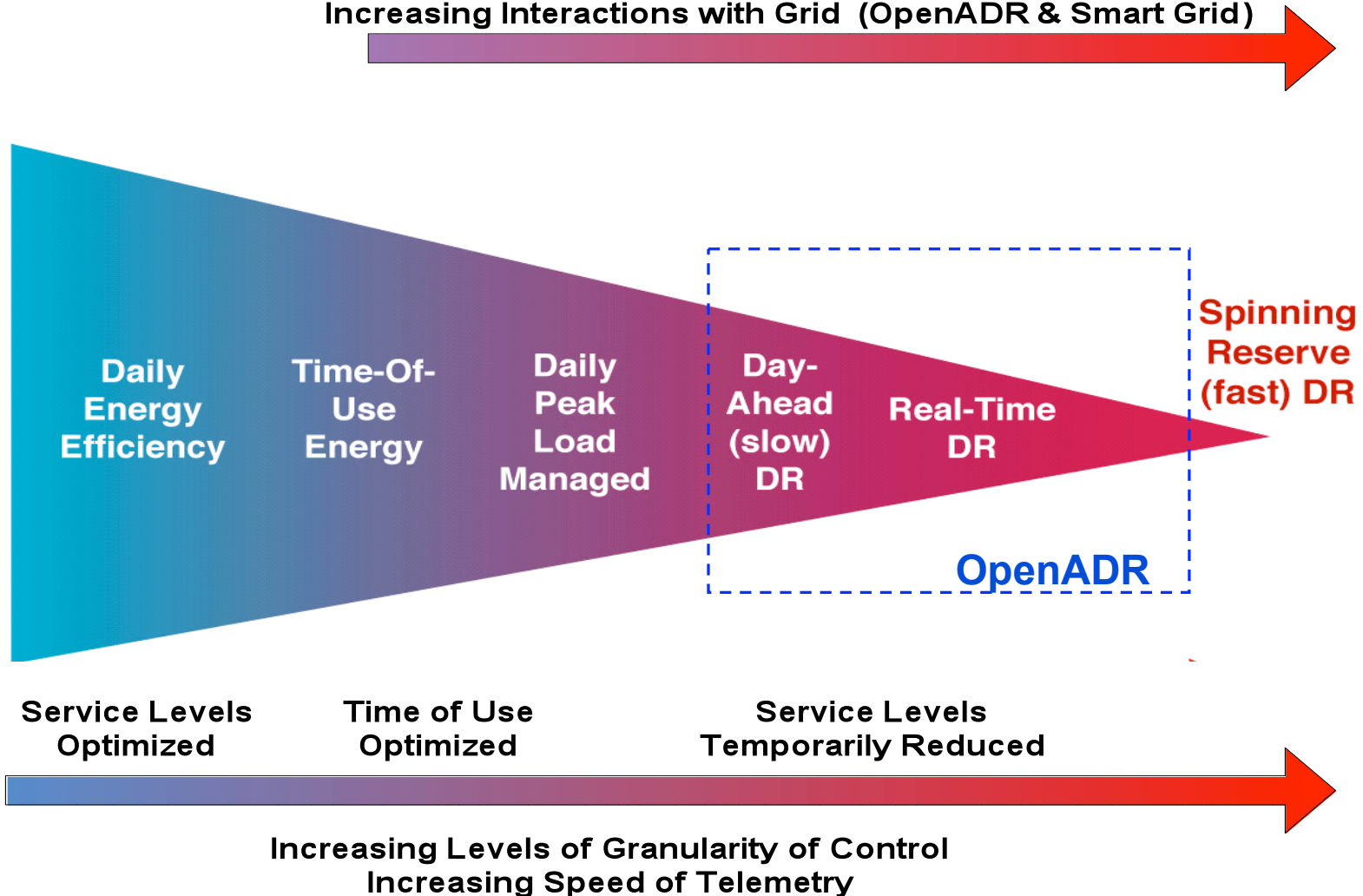


Building use	HVAC									Lighting				Other			
	Global temp. adjustment	Duct static pres. Increase	SAT Increase	Fan VFD limit	CHW temp. Increase	Fan qty. reduction	Pre-cooling	Cooling valve limit	Boiler lockout	Slow recovery	Extended shed period	Common area light dim	Office area light dim	Turn off light	Dimmable ballast	Bi-level switching	Non-critical process shed
ACWD	Office, lab	X	X	X		X		X	X	X							
B of A	Office, data center		X	X	X	X		X									
Chabot	Museum	X					X										
2530 Arnold	Office	X								X							
50 Douglas	Office	X								X							
MDF	Detention facility	X															
Echelon	Hi-tech office	X	X	X		X					X	X	X	X			
Centerville	Junior Highschool	X					X										
Irvington	Highschool	X					X										
Gilead 300	Office			X													
Gilead 342	Office, Lab	X	X														
Gilead 357	Office, Lab	X	X														
IKEA EPaloAlto	Furniture retail	X															
IKEA Emeryville	Furniture retail	X															
IKEA WSacto	Furniture retail																
Oracle Rocklin	Office	X	X														
Safeway Stockton	Supermarket															X	
Solectron	Office, Manufacture	X											X				
Svenhard's	Bakery																X
Sybase	Hi-tech office											X					
Target Antioch	Retail	X				X											
Target Bakersfield	Retail	X				X											
Target Hayward	Retail	X				X					X					X	
Walmart Fresno	Retail	X														X	



Demand Side Management and Automated DR Future

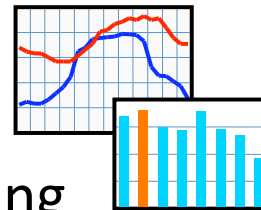
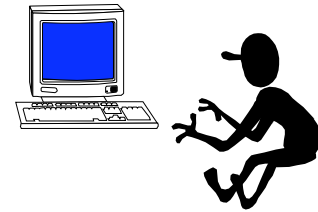
Increasing Interactions with Grid (OpenADR & Smart Grid)



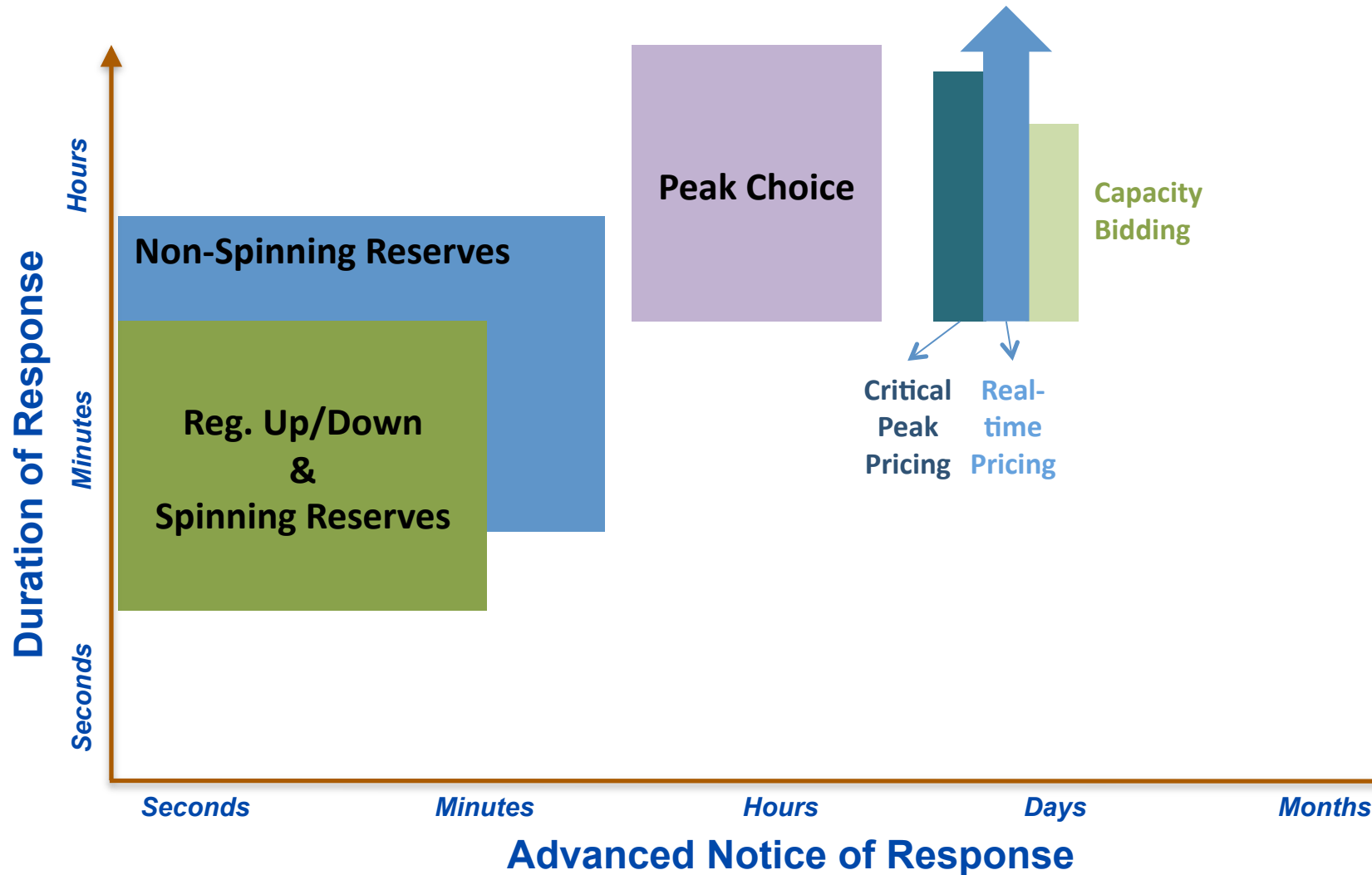
Future Directions

DR strategies as a “Modes” in Optimized Control

- Orchestrate modes using schedules, signals, optimization algorithms:
 - Occupied/Unoccupied
 - Maintenance/Cleaning
 - Warm up/Cool down
 - Night purge/Pre-cooling
 - Low power DR mode
- Intelligence needed for decision making
- Financial feedback systems need to present operational value
- Embed DR communications client in EMCS – work toward codes, support BACnet and LON interoperability



Demand Response Opportunities: Advance Notice and Duration of Response



End Uses and Response

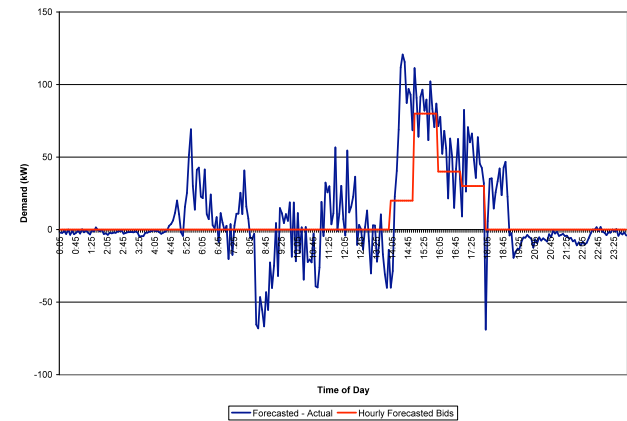
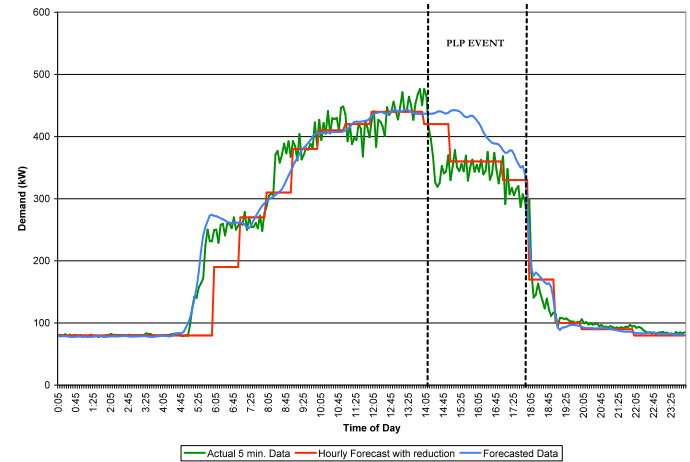


End Use	Type	Modulate	On/Off	Max. Response Time
HVAC	Chiller Systems	Setpoint Adj.		15 min.
	Package Unit	Setpoint Adj.	Disable Compressors	5 min.
Lighting	Dimmable	Reduce Level		5 min.
	On/Off		Bi-Level Off	5 min.
Refrig/Frozen Warehouse		Setpoint Adj.		15 min.
Data Centers		Setpoint Adj., Reduce CPU Processing		15 min.
Ag. Pumping			Turn Off selected pumps	5 min.
Wastewater			Turn Off selected pumps	5 min.

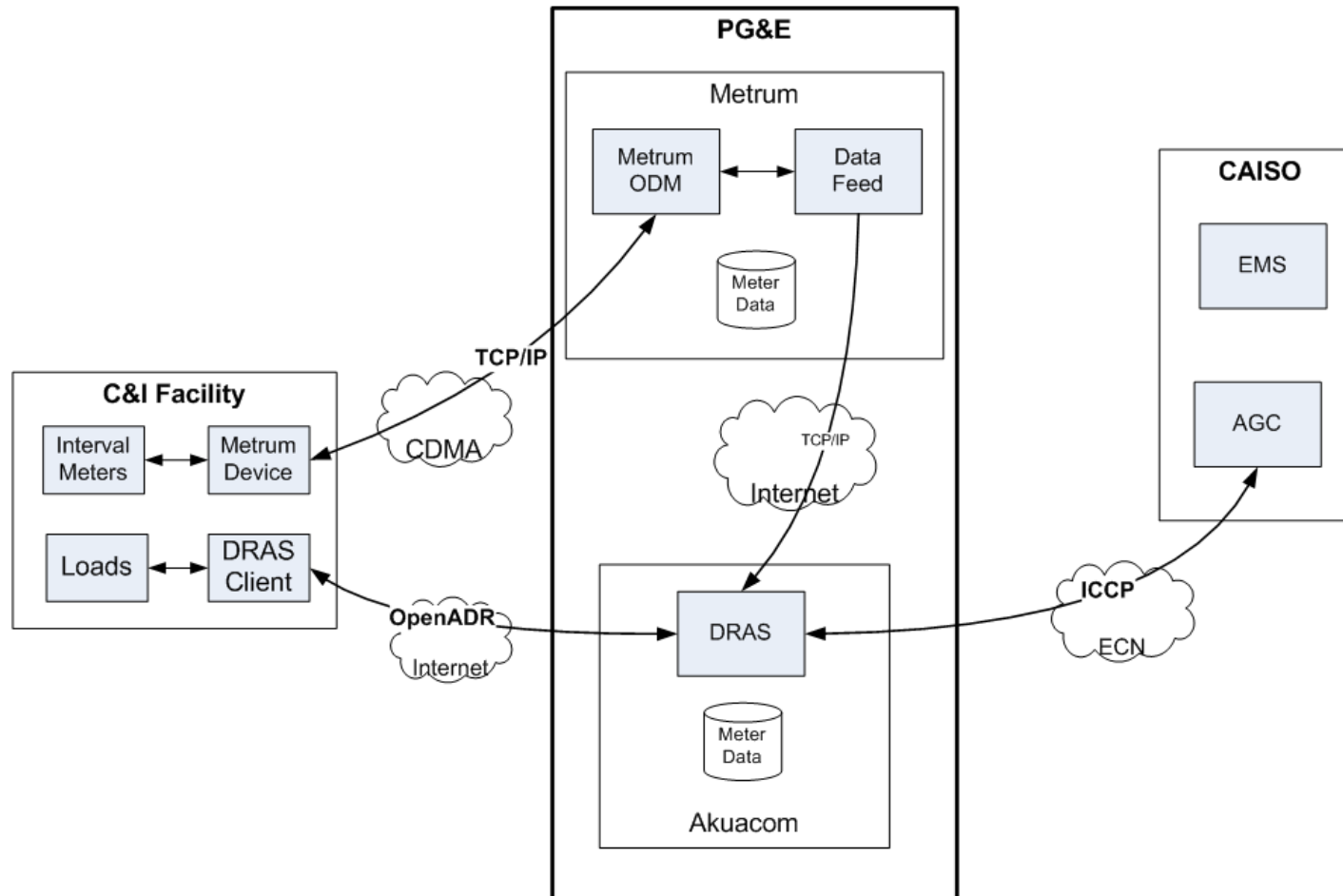
Current Research Area: DR for Integrating Renewable Resources (IRR)

- California's Renewable Portfolio Standards: 33% renewable integration by 2020
- Wind and Solar resources are variable and intermittent
- Challenges:
 - Intra-hour variability
 - Ramping
 - Forecast error
 - Over generation

Goal: Identify strategies to address renewable integration challenges.



Architecture for Pilot: DR as Resource for Managing Grid with Intermittent Renewables



Acronyms:

EMS – ISO's Energy Management System

AGC– Automated Generation Control

ICCP– Inter-control Center Communication Protocol

DRAS – DR Automation Server

Research Questions for Residential Smart Grid Research

- What near-term benefits can consumers expect from Smart Grid deployments?
 - Smart Meters are the most **consumer-visible** elements of today's Smart Grid
 - Smart Meters have been deployed and have already become a **volatile consumer issue**
- When can these benefits be demonstrated?
 - Smart Meters can immediately provide benefits in the form of **near real-time information**

**Utility-owned
AMI Network**

**Utility-controlled
HAN Network**

**End-user
Network**

*Utility Security
Domain*

*HAN Security
Domain*

*Residential
Security
Domain*

AMI
(proprietary)

Zigbee
(SEP 1.0/2.0)

Zigbee

WiFi

(IEEE Std.)

Dedicated Display

Web / TV



Smart Meter
(Itron or Silver Spring)



Utility-approved
Gateway



Cell Phone



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**Critical to Utility
Operations**

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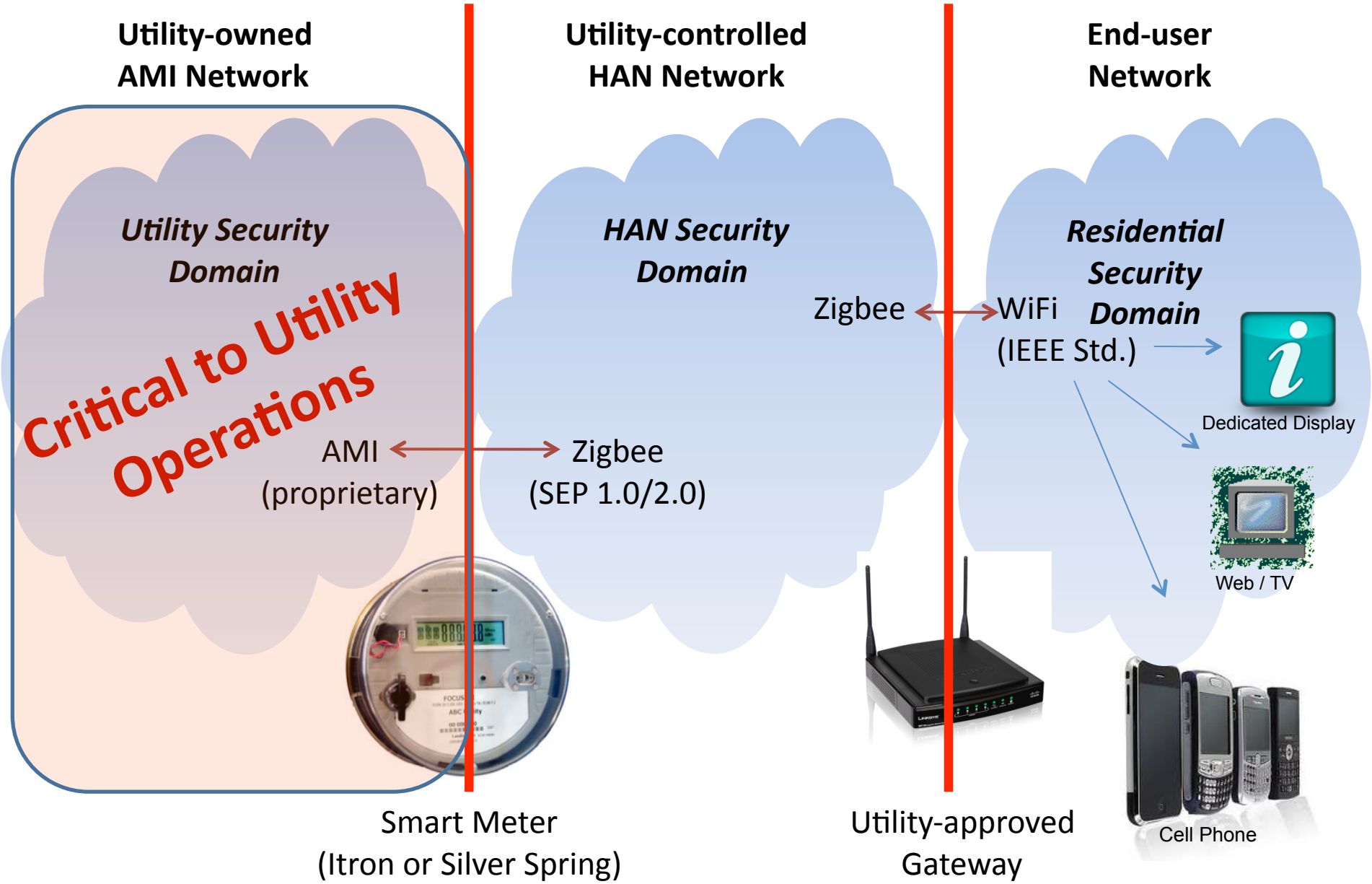
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**Critical to Utility
Operations**

**Operational
Security Concerns!
(all Utilities)**

AMI
(proprietary)

Zigbee
(SEP 1.0/2.0)

Zigbee

WiFi
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Dedicated Display

Web / TV



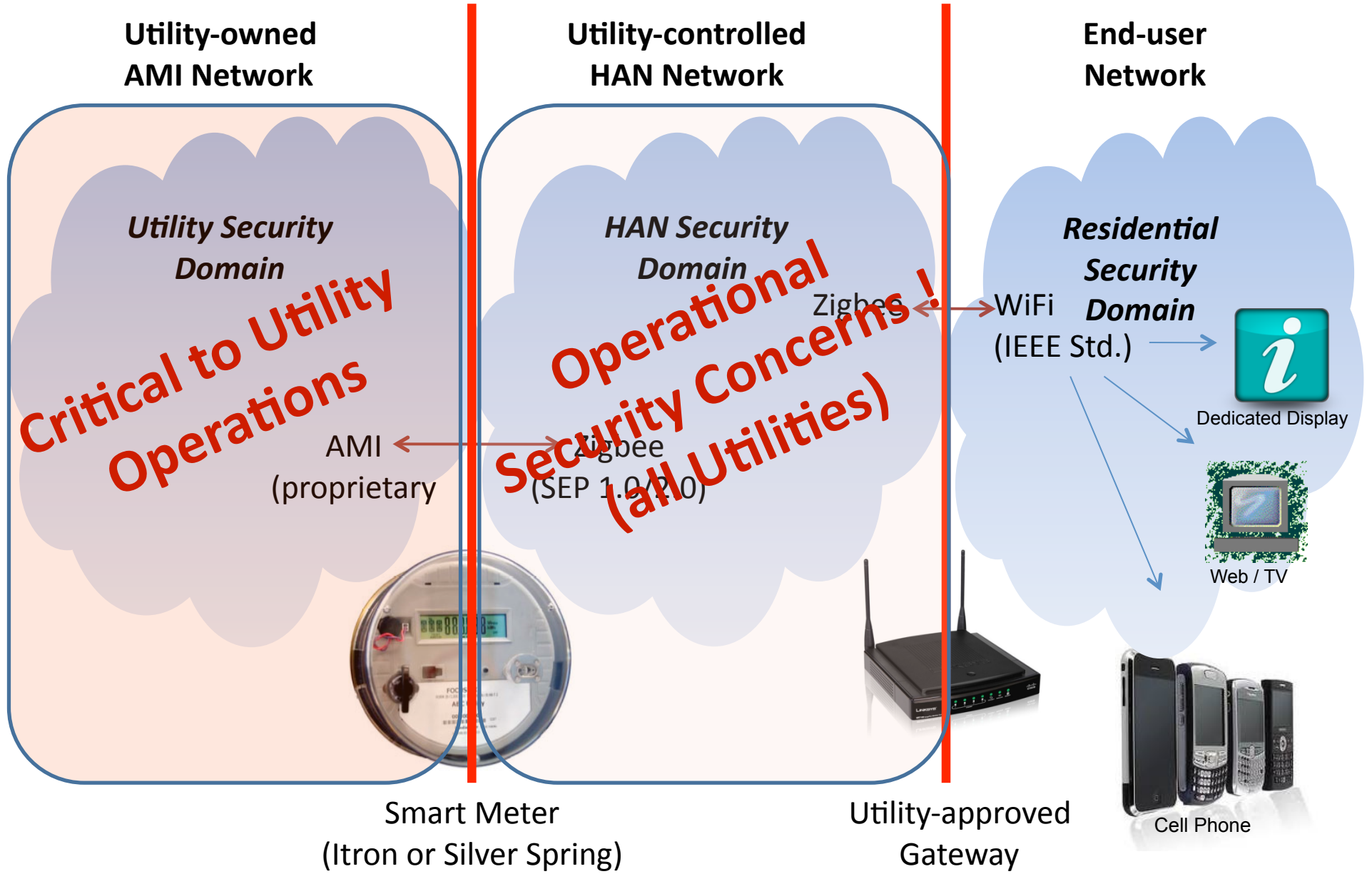
Smart Meter
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Cell Phone



Issues for Present Study

- For utilities willing to enable HAN radios, few devices approved for production use
 - Many devices are available – some with Zigbee certification
 - HAN device ⇔ Smart Meter firmware interoperability testing is ad hoc and lacks market-wide organization
 - HAN device testing not yet mature or consistent across utilities
- In the production environment, many devices are in various stages of “production readiness”
- But...few, if any, devices are usable for widespread field testing

Host Utilities	Proposed Y/N	Network Provider	Comments
LADWP	N	none	No smart meters
MID	Y	Silver Spring	Green field
PG&E	N	Silver Spring	Security concerns
SCE	?	Itron	Have been too busy to respond
SDG&E	Y	Itron	Leverage existing pilots
SMUD	N	Silver Spring	Security concerns

Summary and Future Research

Summary

Automating Demand Response with open standards is making good progress

Need to link advanced controls for efficiency and DR

Future research

- **Additional end-use load evaluations, especially ancillary services**
- **Closer analysis of economics**
- **Continue to explore load and DR predictions**

APPENDICES

DRRC Tools and Guides

- **Surveys and Audit Tools**
 - Site Survey (Commercial)
 - Industrial Controls Survey
- **Guides**
 - Case Studies (C&I)
 - DR Strategies Guide (Commercial)
 - Client Logic w/ Integrated Relay Installation Guide
 - Application Manual for Software Client Development
- **Tools**
 - DR Quick Assessment Tool
 - Load statistical Analysis Tool
 - Weather sensitivity Calculation Tool
 - Baseline Analysis Tool