Welcome!

- Thank you for joining today's webinar: **Advancing DR Automation and Standards in Building Codes (CA Title 24)**
- If you have a question please use the question box located on the right side of your screen.
- Questions for our speaker will be addressed at the end of the presentation.
- This webinar will be recorded for future playback.

openADR ALLIANCE

Today's Speakers

- Girish Ghatikar is a Program Manager with U.S. Department of Energy's Lawrence Berkeley National Laboratory overseeing Demand Response (DR) technologies, Open Auto-DR (OpenADR) standards, international Smart Grid, and energy-related services and markets.

- Heidi Hauenstein (Energy Solutions) manages a project team that provides technical, economic, and political analysis to help inform the California Energy Commission's Title 24 building codes enhancement process on behalf of the California Utility Codes and Standards Team.

openADR ALLIANCE

BERKELEY LAB

LAWRENCE BERKELEY NATIONAL LABORATORY

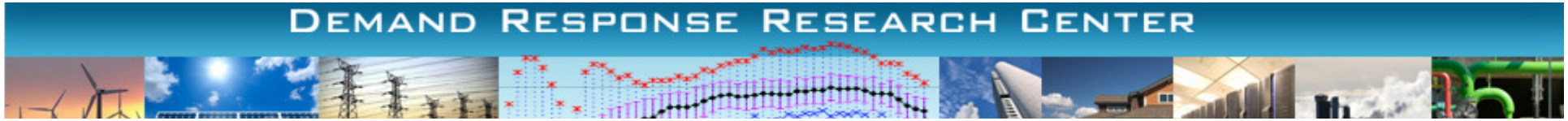
U.S. DEPARTMENT OF ENERGY

California Title 24 Standards and Automated Demand Response

February 24, 2015

Rish Ghatikar, Ella Sung, Mary Ann Piette, and Norm Bourassa
Lawrence Berkeley National Laboratory

Project funded by the California Energy Commission



Agenda

1. Study Goals and Objectives
2. Title 24 Background and DR Automation
3. AutoDR Requirements in Title 24
4. Technical Framework for AutoDR Communications
5. Recommendations

Study Goals and Objectives

Prioritize the development and adoption of Automated Demand Response (AutoDR) standards, acceptance testing, and guidelines for new construction, and accelerate the automation uptake to support grid responsiveness in buildings through California Title 24 standards.

- Develop and propose technical recommendations and guidance language for the “standards-based messaging protocol.”
- Identify mechanisms to understand AutoDR compliance for acceptance testing and propose diffusion strategies.
- Propose technical recommendations for AutoDR diffusion.

What are California Title 24 Building Codes?

- California Energy Commission's (CEC) mandatory Buildings Energy Efficiency Standards
  - Have saved CA's energy customers over $75 billion in reduced electricity bills, since 70s.
  - DR-related requirements first appeared in the 2008 Title 24 (requirement was limited to lighting controls).

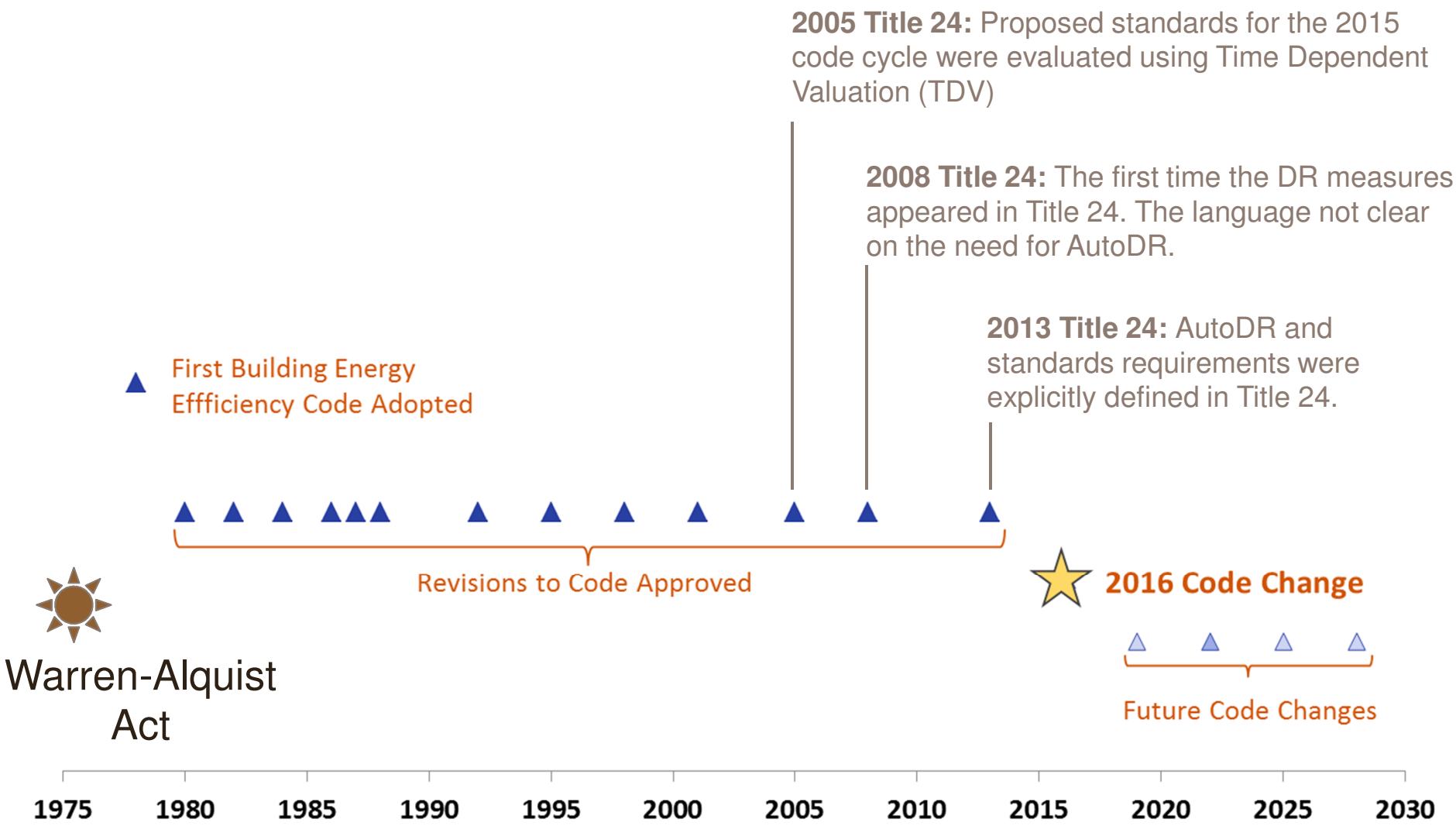
- CA's mandatory 2013 Title 24 codes became effective on July 1, 2014.
  - 2013 Title 24 has requirements for non-residential demand responsiveness and automation in lighting controls, heating and ventilation and air conditioning controls, and sign lighting.
  - It also requires the control system to be able to receive a standards-based demand response signal.

Versions of Title 24

2005 Title 24: Proposed standards for the 2015 code cycle were evaluated using Time Dependent Valuation (TDV)

2008 Title 24: The first time the DR measures appeared in Title 24. The language not clear on the need for AutoDR.

2013 Title 24: AutoDR and standards requirements were explicitly defined in Title 24.



2013 Title 24 and DR Automation

- DR automation requirements for HVAC, indoor lighting, and sign lighting.
- Outdoor signs, non- residential and high-rise residential buildings, and newly constructed hotels and motels —as well as major retrofit projects— must comply with AutoDR-related requirements

Occupancy Type	AutoDR-related Requirements	
	Demand Responsive Lighting Controls ++	Centralized Energy Management Control System for HVAC systems and EMCs
Non-residential, High-Rise Res., and Hotels/Motels	X	X
Signs ++	X	X

2013 T24 Sections with AutoDR Language

California Title 24 Auto-DR Standards and Reference Appendices

SUBCHAPTER 1 - General Provisions

HVAC Systems and Equipment

- SECTION 10-103-B – NONRESIDENTIAL MECHANICAL ACCEPTANCE TEST TRAINING AND CERTIFICATION
- SECTION 110.10 – MANDATORY REQUIREMENTS FOR SOLAR READY BUILDINGS
- SECTION 120.2 – REQUIRED CONTROLS FOR SPACE-CONDITIONING SYSTEMS
- SECTION 120.5 – REQUIRED NONRESIDENTIAL MECHANICAL SYSTEM ACCEPTANCE
- Appendix JA5.2 Required Functional Resources
- Appendix JA5.2.3.1 Price Signals
- JA5.2.3.2 Demand Response Periods
- JA5.2.4 Event Response
- JA5.3 Functional Descriptions
- JA5.3.1 Communications Interface
- JA5.3.2 Expansion/Communication Port
- JA5.3.5 Required Functional Behavior
- NA7.5.10 Automatic Demand Shed Control Acceptance
- NA7.5.10.1 Construction Inspection
- NA7.5.10.2 Functional Testing
- NA7.6.3 Acceptance tests for Demand Responsive Controls in accordance with Section 130.1(e).
- NA7.6.3.1 Construction Inspection

Lighting Controls and Equipment

- SECTION 130.1 – INDOOR LIGHTING CONTROLS THAT SHALL BE INSTALLED
- SECTION 130.1 – INDOOR LIGHTING CONTROLS THAT SHALL BE INSTALLED
- SECTION 130.5 –ELECTRICAL POWER DISTRIBUTION SYSTEMS
- SECTION 140.6 – PRESCRIPTIVE REQUIREMENTS FOR INDOOR LIGHTING
- SECTION 130.4 –LIGHTING CONTROL ACCEPTANCE AND INSTALLATION CERTIFICATE REQUIREMENTS
- Appendix NA7– Installation and Acceptance Requirements for Nonresidential Buildings and Covered Processes
- Appendix NA7– Installation and Acceptance Requirements for Nonresidential Buildings and Covered Processes (continued)
- Appendix NA7.6.3.2 Functional testing of Demand Responsive Lighting Controls

Electronic Message Centers (EMCs)

- SECTION 130.3 – SIGN LIGHTING CONTROLS

AutoDR Requirements in Codes

Automated Demand Response (AutoDR) enables customers to reduce electric demand upon the receipt of a remote signal from an electric utility, Independent System Operator (i.e., CAISO) or the designated Curtailment Service Provider/Aggregator (CSP) with no human in the loop.

- **Purpose of the language:**
  - Provide guidance to architects, engineers, vendors, and contractors as they specify, design and build systems in the future.
  - Prevent code to become irrelevant or counterproductive due to changes in AutoDR signaling standards that may occur over the next several years.
  - Enable AutoDR measures to multiple utility and wholesale DR markets signals.

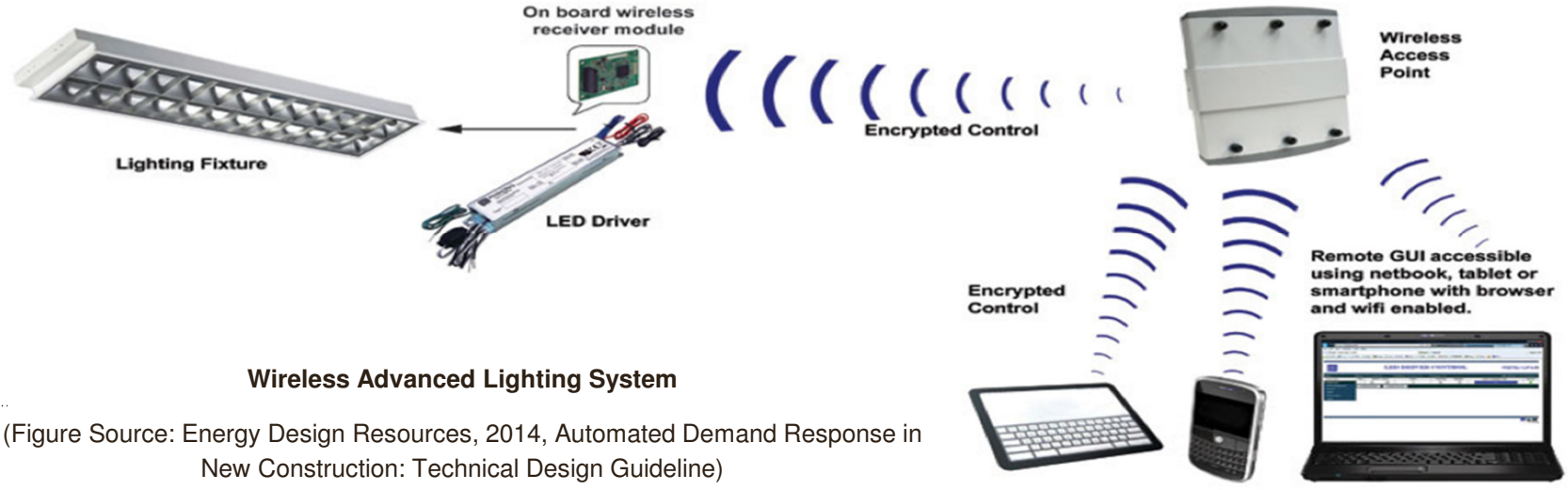
AutoDR Terms and Definitions from 2013 T24

- ***Demand Response Signal*** is a signal sent by the local utility, Independent System Operator (ISO), or designated curtailment service provider or aggregator, to a customer, indicating a price or a request to modify electricity consumption, for a limited time period. The DR Signal attributes and requirements shall be specified within the messaging protocol utilized by the utility or other entity selected by the occupant.
- ***Demand Responsive Control*** is a kind of control that is capable of receiving and automatically responding to a DR signal.
- ***Demand Response Period*** is a type of event response and refers to the period of time during which electricity loads are modified in response to a DR signal.
- ***Price Signal*** is a type of event response and refers to the utility or entity to send a signal or message to occupant's system to provide pricing information to occupant and initiate DR Control for DR Period utilizing a DR Signal.

How to ensure customer equipment is AutoDR compliant when an unknown external provider (e.g., utility) sends the DR signals?

Lighting AutoDR-related requirements and acceptance testing

End Use System	AutoDR triggering Conditions	System Response Requirements	Equipment Needed for Compliance	Acceptance Test Requirements
Lighting Controls	· Building area ≥ 10,000 square feet · Habitable spaces where lighting power density is > 0.5 watts/square foot	· Reduce lighting load ≥ 15% for a control · Reduce lighting level to the uniform level of illumination requirement in Table 130.1-A from 20013 Title 24	· AutoDR-ready lighting control system OR · AutoDR-ready EMCS	1. Capable of receiving and automatically responding to at least one standards-based messaging protocol and enabling DR after receiving a DR signal. 2. Reduce lighting load ≥ 15% using the illuminance measurement or full output test method.
Electronic Messaging Center (EMC)	· Lighting load > 15kW	· Reduce power ≥ 30%	· Centralized or decentralized AutoDR-ready lighting control system OR · AutoDR-ready EMCS	**No acceptance test required (Declaration required)**



Wireless Advanced Lighting System

(Figure Source: Energy Design Resources, 2014, Automated Demand Response in New Construction: Technical Design Guideline)

HVAC AutoDR-related requirements and acceptance testing

End Use System	AutoDR triggering Conditions	System Response Requirements	Equipment Needed for Compliance	Acceptance Test Requirements
HVAC System with DDC to the Zone Level	· Non-critical zones	· Capable to remotely reset the temperatures or to original operating levels. · Capable to remotely set up the operating cooling set points by 4 degrees or more to a signal from a centralized contact or software point within an EMCS · Cooling set points in the critical spaces do not change	· Centralized HVAC Controller OR · AutoDR-ready EMCS	1) The EMCS interface enable activation of the central demand shed controls 2) Same as system response requirements
HVAC System without DDC	· Non-temperature sensitive processes		· Demand-responsive setback thermostat (also called OCST) AutoDR-ready EMCS	**No acceptance test required (self-certification by manufacturers)**

Centralized HVAC Controller

(Figure Source: Energy Design Resources, 2014, Automated Demand Response in New Construction: Technical Design Guideline)

HVAC Systems and Equipment – OCST

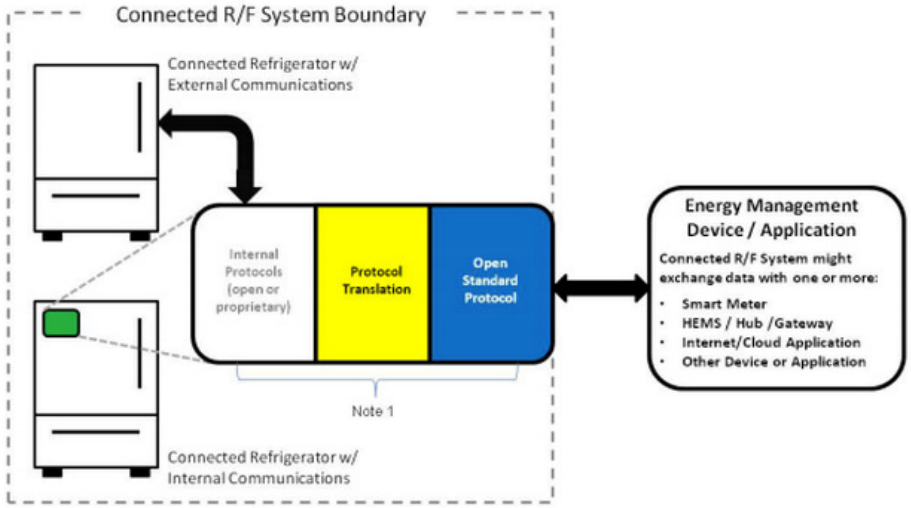
Joint Appendix 5 - Technical Specifications For Occupant Controlled Smart Thermostats (OCST)

Includes standards-based messaging protocol definition – "including but not limited to Smart Energy Profile (SEP), OpenADR or others defined in the Smart Grid Interoperability Panel (SGIP) Catalog of Standards (CoS) or as defined by the occupant's information update service or Demand Response service provider."

Parts about communication architecture and techniques are not written in an intuitive language for architects and engineers. Requires self certification by vendors.

Need illustrative examples, EPA Energy Star requirements, AutoDR standards that utilities use.

Figure 1. Connected Refrigerator/Freezer System Boundary – Illustrative Example



Note 1: Communication device(s), link(s) and/or processing that enables open standards-based communication between the Connected R/F System and Energy Management Device/Application(s). These elements could be within the base appliance, and/or an external communication module, a hub/gateway, or in the Internet/cloud.

Reference : ENERGY STAR® Program Requirements Product Specification for Residential Refrigerators and Freezers Eligibility Criteria Version 5.0

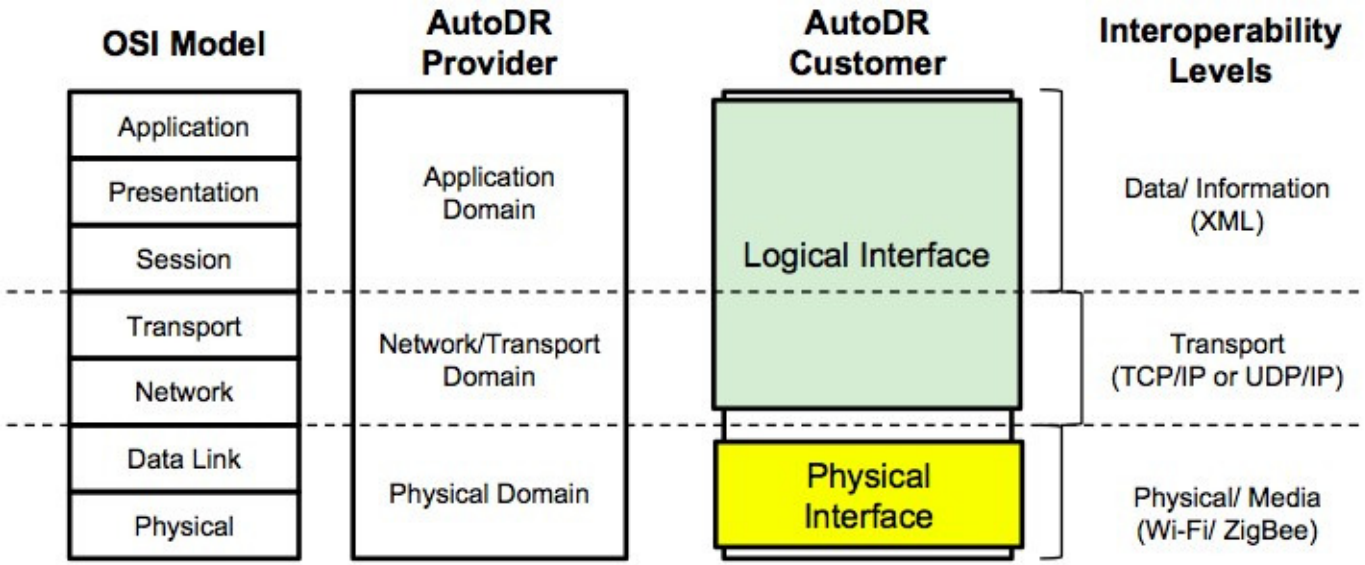
DR Automation Framework for Interoperability

- Standards-based messaging protocols for DR signals ensure that a customer's installed AutoDR equipment is interoperable, can be enabled for plug-and-play operation, and ready to participate in utility's AutoDR program(s).
- The seven-layer OSI model, is an important framework for well-defined communication interfaces to any networked system:

  1) ***Physical Domain****:* Most capital intensive to develop and deploy.

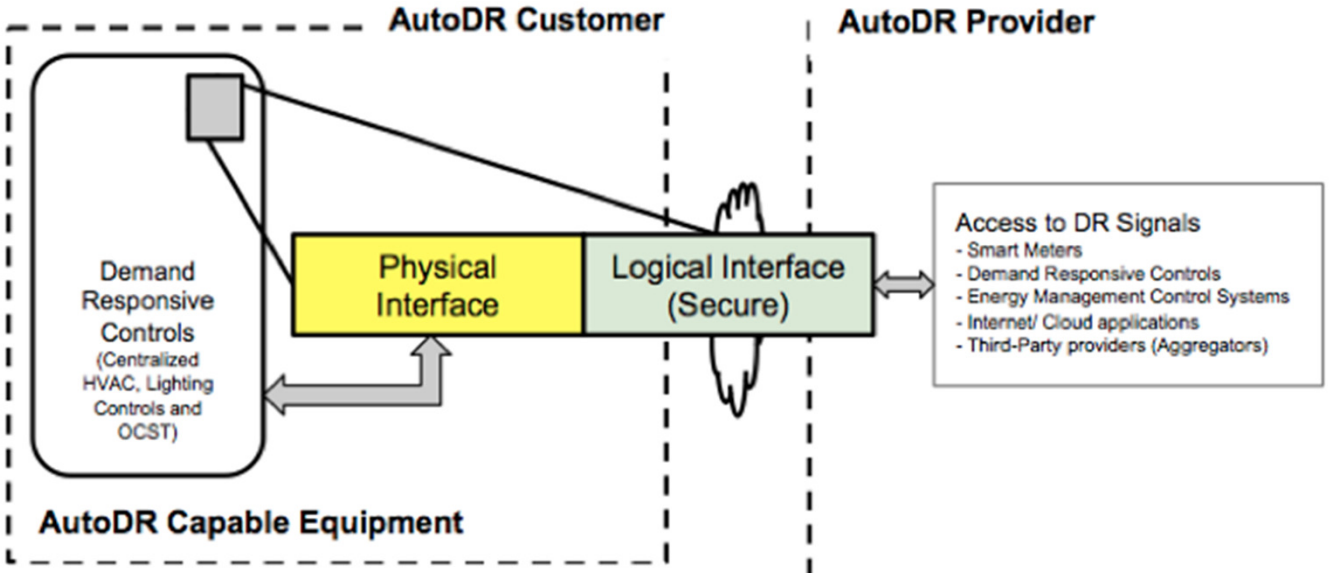
  2) ***Network/Transport Domain:*** Usually based on the Internet Protocol (IP)

  3) ***Application Domain:*** Most innovation happens here; data constructs for AutoDR program interoperability and cyber-security are defined.

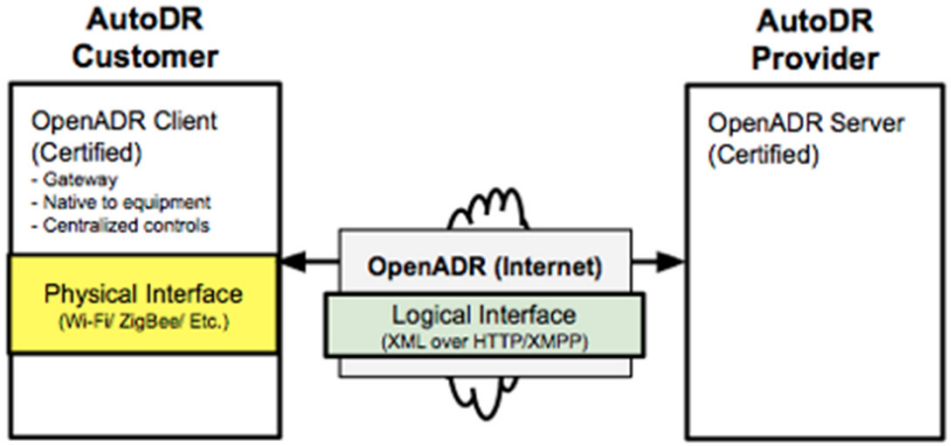


BERKELEY LAB

Automation Framework (Continued)



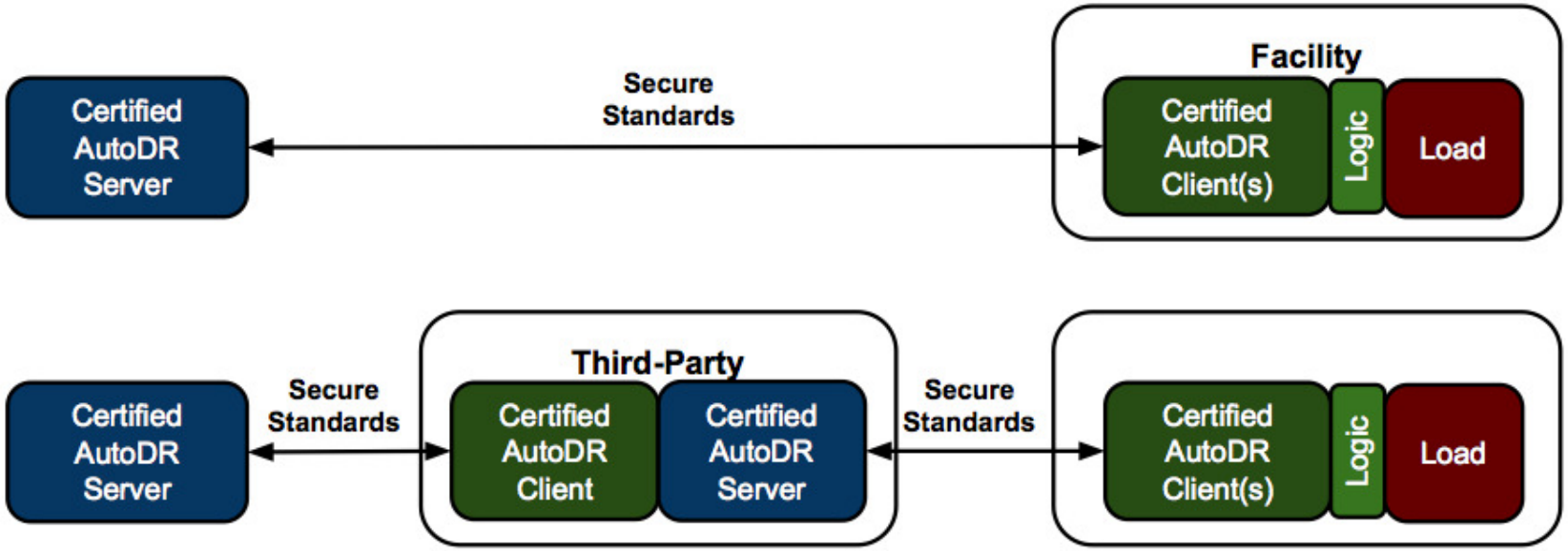
Mapping Physical and Logical Interfaces for Demand Response Signals



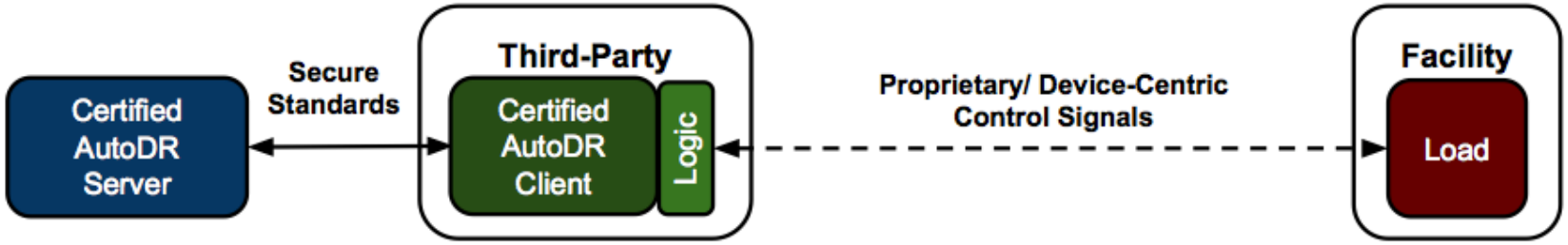
Interoperable communications of the logical interface using the OpenADR 2.0 standard

BERKELEY LAB

Examples of Communication Architectures*



Standards-based Communication between Certified AutoDR Server and Clients (***Top**: Direct communication between DR service provider's AutoDR server and facility's AutoDR client; **Bottom**: In-direct communication, through a third-party, AutoDR server and facility's AutoDR client.*)



Standards-based Communication between Certified AutoDR Server and Third-party AutoDR Client; Proprietary or Device-Centric Controls Signals between Third-party and Facility loads

* Gonzalez A., H. Hauenstein, G. Ghatikar, and P. Eilert; Codes & Standards Opportunities for Demand-Side Smart Grid Deployment; Submitted to the Proceedings of the ACEEE Summer Study on Energy Efficiency in Buildings. Pacific Grove, CA .

Technical Framework: Benefits

- To ensure that *the logical interface* provides demand responsive controls and interoperable plug-and-play capability, use of nationally recognized and industry-supported standards are key.
  - Vendors can develop new products with same standard software that can easily interoperate with AutoDR program signals.

- Customer costs for enabling AutoDR can be lower, when added and *certified* for compliance during product development (economies of scale).
  - Self-certification has issues!

California Energy Commission

2013 Manufacturer Certification for Equipment, Products and Devices

Occupant Controlled Smart Thermostat Declaration List

OCST Model Name	OCST Model Number	Enabled Communication Capabilities (Onboard, or Expansion Port)	Communication Module Name	Communication Module Number	Physical Communication Standard Nam	Messaging Protocol Name
ZigBee Communicating TB7200, Honeyw	TB7200C5014W/U	Onboard, Zibgee when using an EMS	na	na	IEEE 802.15.4-2003	ZigBee Wireless Mesh
BACnet communicating TB7200, Honeyw	TB7200C5014B/U	Onboard, BACnet when using an EMS	na	na	EIA 485	BACnet MSTP
Communicating T7350H, Honeywell	T7350H1009/U	Onboard, LONWORKS when using an EMS	na	na	Echelon FT10	ANSI 709.1
Communicating T7350H, Honeywell	T7350H1017/U	Onboard, LONWORKS when using an EMS	na	na	Echelon FT10	ANSI 709.1
Internet Programmable Thermostat, Peli	TS200	Onboard	na	na	IEEE 802.15.4	OpenADR 2.0
ColorTouch Thermostat	T5800	Expansion Port	Wi-Fi key	ACC0454	IEEE 802.11 b/g	ADR
Magnum Enocean communicating 24V T	M9-TS1	Onboard	na	na	ISO/IEC 14543-3-10	Enocean Wireless Protocol

Findings from Technical Analysis

- Huge potential to *improve the language of 2013 Title 24 AutoDR definitions of terms, guidelines, and acceptance testing criteria* for the controls and equipment subject to Title 24 compliance acceptance testing

- Enablement of developing interoperable demand responsive controls and equipment that can respond to external DR signals

  → Low-cost automation through diffusion

Relevant U.S. Standards and Activities*

Building Code	Strategy to Encourage Participation in DR Transactions				
	Curtailable Load	DR Controls	Certification of DR Systems	Participation in DR Transactions	Monitoring & Reporting
Base Codes					
2013 Title 24 (Part 6), California Building Energy Efficiency Standards	Yes	Yes	Yes	No	Yes
ASHRAE 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings	Yes	No	No	No	Yes
2012 International Energy Conservation Code (IECC)	Yes	No	No	No	No
2012 International Res. Code (IRC)	Yes	No	No	No	No
Reach Codes and Building Rating Systems					
2013 CALGreen (Title 24, Part 11), California Green Building Standards	Yes	Yes	Yes	No	Yes
ASHRAE 189.1-2011, Standard for the Design of High Performance Green Buildings Except Low-Rise Residential Buildings	Yes	Yes	No	No	No
International Green Construction Code (IGCC)	Yes	Yes	No	No	No
LEED DR Credit by U.S. Green Building Council (USGBC)	Yes	Yes	Yes	Yes	No

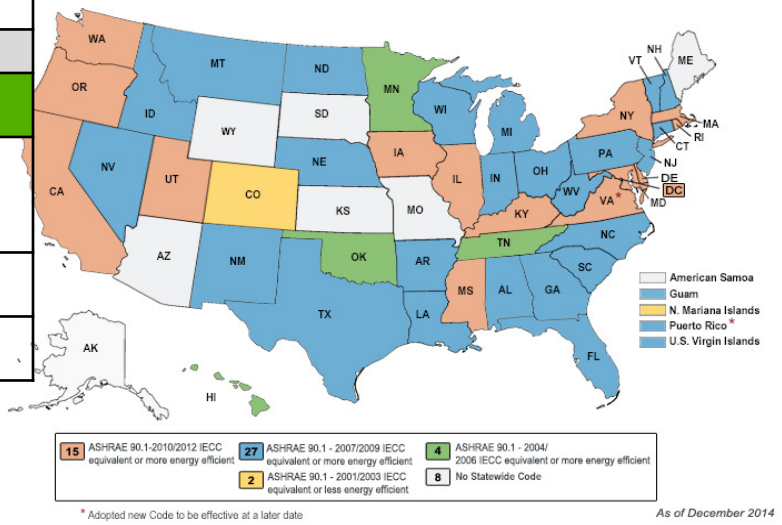


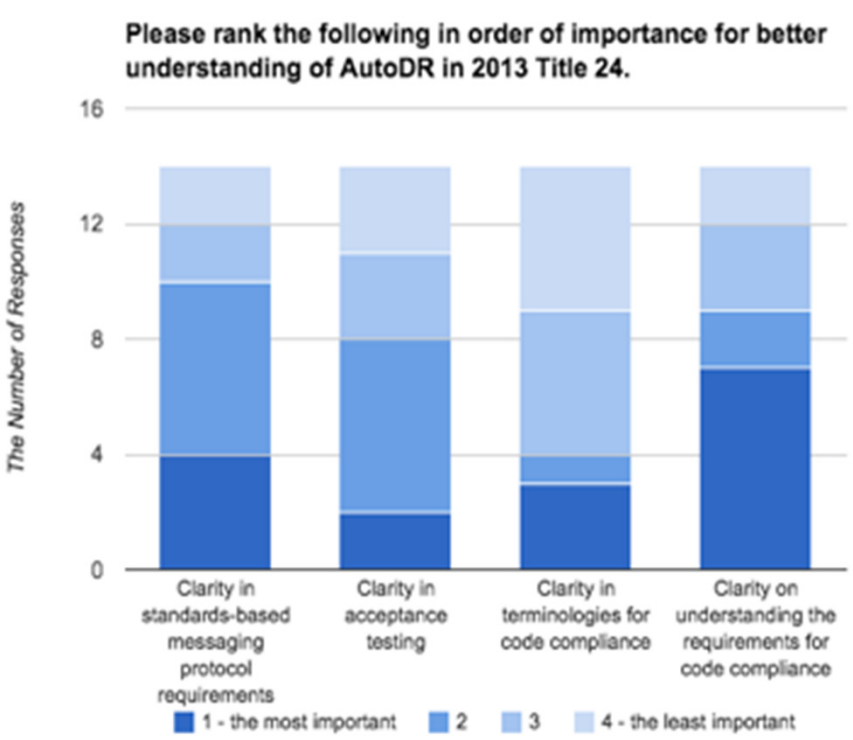
Figure Source: http://www.energycodes.gov/adoption/states

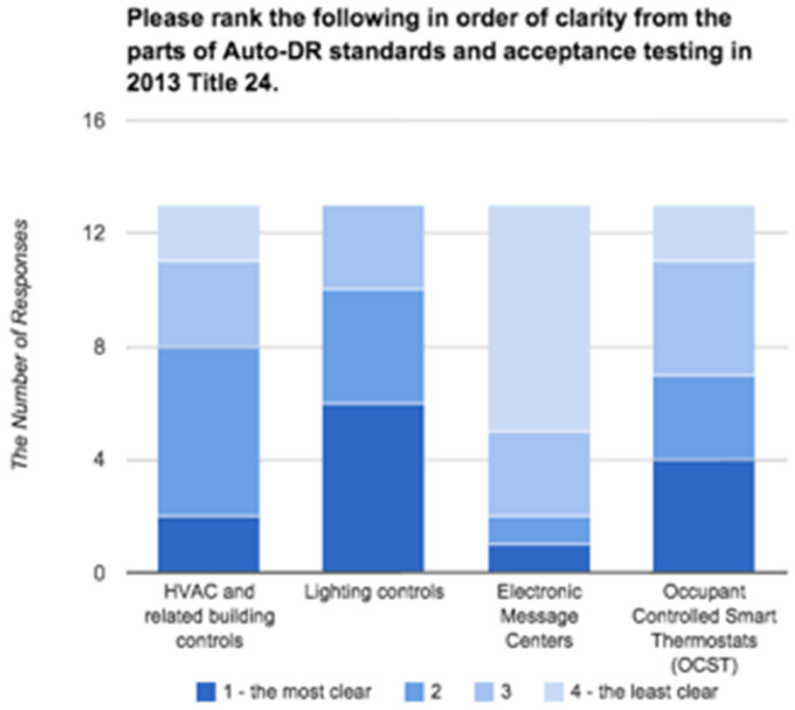
* Gonzalez A., H. Hauenstein, G. Ghatikar, and P. Eilert; Codes & Standards Opportunities for Demand-Side Smart Grid Deployment; Submitted to the Proceedings of the ACEEE Summer Study on Energy Efficiency in Buildings. Pacific Grove, CA .

BERKELEY LAB

Findings from Survey Results

- 15 of the 18 participants from November workshop completed the survey.
- 5 questionnaires were asked to explore key issues in code language, compliance, market, and diffusion of DR automation

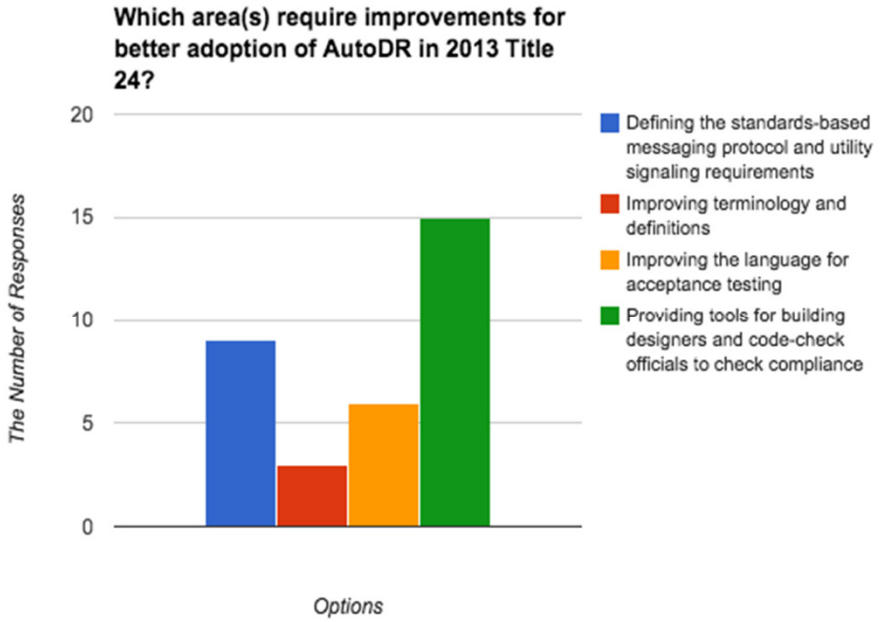


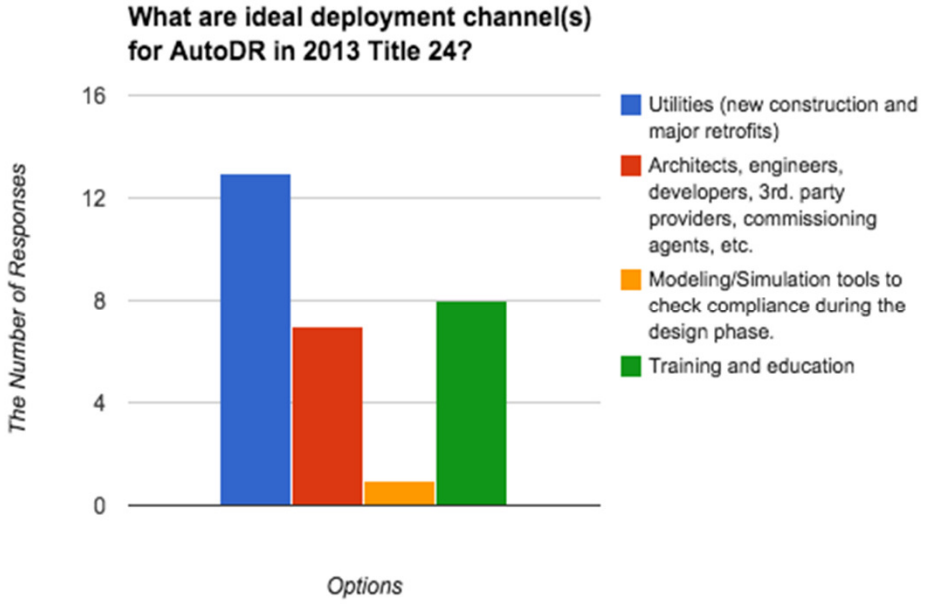


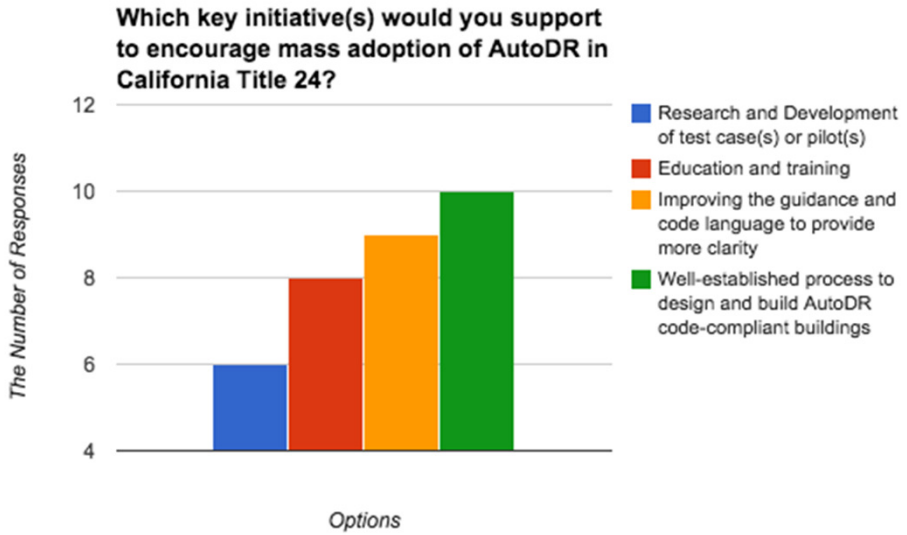
Survey Results: AutoDR Standards Clarity and Acceptance Testing Priorities in 2013 Title 24

BERKELEY LAB

Survey Findings (Continued)







Survey Results: Market adoption of DR automation

BERKELEY LAB

Suggested Recommendations

- AutoDR standards and acceptance test requirements should be *clear, consistent, and easily understood*.
  - Stronger framework and certification for "standards based messaging protocol," based on national standards for DR/DER (e.g., OpenADR 2.0 and SEP 2.0).

- *Accessible and understandable education and training programs, and intuitive tools for code-compliance checking* should be provided.

- Utilities, city departments, and public commissions should build internal infrastructure to communicate *existing and new AutoDR-related information to the customers and building communities in a clear and consistent manner*, and *exchange feedback to improve program design and the code language*.

Paper for European Council for Energy Efficient Economy will be submitted in March 2015.

Ghatikar G., E. H Sung, and M. A Piette, "**Diffusion of Automated Grid Transactions Through Energy Efficiency Codes**," ECEEE Summer Study, 2015 (in press)

Discussions

- Contact:
  - GGhatikar@lbl.gov