1 **OpenADR 1.0 System Requirements Specification**

2 ***Version:*** *Draft v0.5*

3 Issued for review prior to Draft 2 on: 6/23/2010

4 **[Draft 2] Release Date: 6/23/2010**

5 Acknowledgements

6 The following individuals and their companies have contributed and/or provided support to the
7 work of the OpenADR System Requirements Specification:

8   •

9 The OpenADR Task Force wishes to thank all of the above-mentioned individuals and their
10 companies for their support of this important endeavor, as it sets a key foundation for an
11 interoperable Smart Grid.

12 # Document History

13 ## Revision History

14 Date of this revision: April 13, 2010

15

Revision Number	Revision Date	Revision By	Summary of Changes	Changes marked
0.1	4/13/2010	Bruce Bartell	Initial draft "shell" based on OpenADE SRS	N
0.2	4/20/2010	Bruce Bartell	Updated through sections 3.2.1	N
0.2	4/30/2010	Bruce Bartell	Updated through sections 3.2.2	N
0.3	5/1/2010	Ed Koch	Scope update and comments for F2F	N
0.4	5/7/2010	Bruce Bartell	Incorporate feedback from OSG Quarterly	N
0.4	5/14/2010	Bruce Bartell	Added Integration Service Messages based on Entity, Priorities.	N
0.4	5/18/2010	Bruce Bartell	Added attributes & definitions for Priority 1 messages	N
0.5	6/11/2010	Bruce Bartell	Attributes & definitions for priorities 2,3. Revised process model to match current PAP09 Retail. Moved open items to issues/open items log.	N
0.5	6/23/2010	Bruce Bartell	Incorporated comments for Open Items log. Corrected some items in data requirments.	N

16 ## Open Items and Issues Log

17 Last updated: June 23, 2010

18

19 As open items and issues are addressed in new versions of this document, they are removed from this list.

20

Item No.	Date	Provided By	Summary of the Issue
1	6/11/2010	B. Bartell	Publishing Interval removed from Pricing Signal. Implementation item. Need a Use Case. Where would this be available if not in the DR signal?
2	6/11/2010	B. Bartell	PAP09 Wholesale Data Requirements from "Smart Grid Communication Standards for Demand Response Data Requirements – (IRC) ISO/RTO Council for PAP09" which did not map to existing Retail requirements are out of scope. Common model will be addressed as part of PAP09 Phase 2 effort.
3	6/11/2010	B. Bartell	SEP2.0 Data elements for DLC not in the data requirements: DR Program Type, DR Group. Do they need to be supported? Is DR group = DR Resource? Optional SEP 2.0 HAN Device IDs HAN Device Class

			Heating Temperature offset/setpoint Cooling Temperature offset/setpoint Load adjustment offset Duty cycle Event control DR event cancel control Cancel effective date/time Requesting input from the SEP2.0 Team.
4	6/11/2010	B. Bartell	Is there are requirement for Dispatch type for temperature based dispatch? Possibly. Used as part of Day ahead pricing market. Possible "Trigger" as 4th type of DR Signal. "Trigger Type" and "Trigger Value".
5	6/11/2010	B. Bartell	Is Customer Enrollment in scope? Removed from PAP09 Retail.
6	6/11/2010	B. Bartell	Detail diagrams from PAP09 Retail contain message for Scheduling, Forecasting, Nominations, Capability, Aggregated Capability, Telemetry Data, Aggregated Telemetry Data. No content was defined for these messages. Are they in scope of this or future releases? In scope of future releases. Cover as part of Phase 2.
7	6/11/2010	B. Bartell	Figure for REC-VEN operations is from *EPRI Concepts to Enable Advancement of Distributed Energy Resources*. Do we need explicit permission to use as is?
8	6/11/2010	B. Bartell	Source-Authentication removed as data requirement. Included in Technical Architecture requirements. The recipient must have some assurance that the message was produced by a reliable, authoritative party. This will require some ability to validate the authenticity of the source and integrity of the data (e.g., digital signature applied to a price message). Must address in context of non-repudiation. May be use case specific.

21

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1 Introduction

The Open Smart Grid Open Automated Demand Response (OpenADR)[1] is an industry-led initiative under the Open Smart Grid (OpenSG) subcommittee within the UCA International Users Group (UCAIug). The OpenADR Task Force defines systems requirements, policies and principles, best practices, and services, required for business and data requirements for standardizing control and pricing signals for Demand Response (DR) and Distributed Energy Resources (DER) as part of the Smart Grid implementation[2]. OpenADR, as an open user group forum, is developing a set of utility-ratified requirements and specifications for utilities and 3rd Parties to adopt and implement. The end-state of this effort will contribute to the development of open and interoperable Demand Response solutions.

This will be achieved by defining and making the following OpenADR related items available to the market:

- Common business processes and functional requirements

- Common architecture principles and patterns

- Common information requirements and model

- Common integration services (functional & informational)

1.1 Purpose

The purpose of this document is to provide both the functional and technical guidance and requirements needed to serve as the "rules of engagement" for messaging and data exchange to achieve interoperability. This would lead to open and interoperable components that can be delivered with different vendor products and/or solutions within the scope of OpenADR. The functional requirements will be driven by business processes and the technical requirements will be driven by desired architectural principles and best practices.

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[1] The OpenADR Task Force of the Open Smart Grid Users Group acknowledges the work coordinated by the Demand Response Research Center and funded by the California Energy Commission (Energy Commission), Public Interest Energy Research (PIER) Program in development of the *Open Automated Demand Response Communications Specification*, also known as OpenADR or Open Auto-DR. For the purposes of this document the specification will be cited using the full title. The term OpenADR SRS or SRS refers to the *OpenSG OpenADR System Requirements Specification*.

[2] *Requirements Specifications for Wholesale Standard DR Signals - for NIST PAP09, Requirements Specifications for Retail Standard DR Signals - for NIST PAP09*

1.2 Scope

88

89 The SRS focuses on the requirements to support the interactions and exchange of information for the
90 purposes of Demand Response (DR) and includes the exchanges of DR related information between
91 various entities dealing with the Utilities, such as Independent System Operators (ISO's), Aggregators,
92 Energy Service Providers and end use customers. The scope of OpenADR SRS includes standardizing
93 dispatch, control and pricing signals for DR and Distributed Energy Resources (DER) as part of the
94 Smart Grid implementation as defined in Section 1.4 External Considerations and References.

95 Demand Response is defined as the temporary modification of customer energy usage for a defined
96 duration which is triggered by some condition on the grid such as reliability or market conditions. These
97 DR events result in the exchange of "DR signals" between service providers such as Utilities, ISO's,
98 Aggregators, ESP's, etc. and their customers. The information in the DR signals causes modifications to
99 the end users load profiles. The requirements in the SRS are from the perspective of the enterprise
100 systems of the service providers that are publishing the DR signals to their customers (i.e. Utility). This
101 is in contrast to the customer's systems or perspective which is covered in other efforts such as
102 OpenHAN and SEP. The thing that all the various efforts have in common is the need to exchange the
103 DR related information in some standardized form. Furthermore this SRS does not cover many of the
104 administrative aspects of managing a DR program such as measurement and verification and settlement.
105 The SRS is focused on only those aspects of DR management that is required to facilitate the exchange
106 of DR signals with their customers.

107 The SRS defines the logical components and business functions in order to identify the interfaces that
108 must be specified to enable interoperability across different implementations, for many utilities to many
109 3rd Parties. It includes architectural aspects and specific requirements. The inputs include OpenADR
110 use cases, as well as industry best practices and standards, including information models and other
111 specifications.

112 1.2.1   Scope of This Release

113 OpenADR SRS 1.0 addresses the following functional areas:

114 • Direct Load Control Signals

115 • Dispatching of Load Profiles

116 • DR Related Pricing Signals

117 • DER applications (limited to the context of grid-connected DR)

118 • DR Program Management (Limited to data required to support DR Signals)

119   o Program and Customer Registration

120   o DR Resource Registration

121 ## 1.2.2 Scope of Subsequent Releases

122 • Utility internal systems integration for DR purposes

123 • DR Bidding

124   o DR Offer to Supply (Retail Offers)

125   o DR Bid to Buy

126 • Forecasting

127

128

129 The OpenADR SRS does not include the following items that are typically a part of solution architecture. Some
130 of them are or have been addressed by other parts of the OpenSG initiative. Others will need to be dealt with
131 specifically for each implementation.

132   ▪ Network and hardware infrastructure architecture

133   ▪ Operational architecture

134   ▪ Testing methodology and architecture

135   ▪ Internal application architecture

136 # 1.3 Acronyms and Abbreviations

137 This subsection provides a list of all acronyms and abbreviations required to properly interpret the OpenSG
138 OpenADR System Requirements Specification.

Acronym	Name
ADE	Automatic Data Exchange
ADR	Automated Demand Response
AMI	Advanced Metering Infrastructure
CIM	IEC TC57 Common Information Model
DLC	Direct Load Control
DR	Demand Response
EMS	Energy Management System
ESP	Energy Service Provider
ESI	Energy System Interface; Energy Services Interface
HAN	Home Area Network
IETF	Internet Engineering Task Force
IHD	In-Home Display
ISO	Independent System Operator
IT	Information Technology
M&V	Measurement and Verification
NERC	North American Electric Reliability Corporation
PHEV	Plug-In Hybrid Electric Vehicle
RTO	Regional Transmission Organization

RTP	Real Time Pricing
SDO	Standards Development Organization
SEP 2.0	Smart Energy Profile
SLA	Service Level Agreement
SRS	System Requirements Specification
TOGAF	The Open Group Architecture Framework

139
140

1.4 External Considerations and References

142 The work of the OpenADR SRS is dependent upon the requirements defined in the following sources:

143

144 • Open ADR Functional Requirements and Use Case Document (OpenSG)
145 • Requirements Specifications for Wholesale Standard DR Signals - for NIST PAP09
146 • Requirements Specifications for Retail Standard DR Signals - for NIST PAP09
147 • OPEN AUTOMATED DEMAND RESPONSE COMMUNICATIONS SPECIFICATION - Public Interest
148   Energy Research (PIER), California Energy Commission
149 • Requirements Specifications for Common Electricity Product and Pricing Definition - for NIST PAP03
150 • Requirements Specifications for Common Scheduling Mechanism for Energy Transactions - for NIST PAP04
151 • ZigBee Smart Energy Profile™ 2.0 Technical Requirements Document
152 • Energy Information Standards (EIS) Alliance Customer Domain Use Cases
153 • Energy Information Standards (EIS) Alliance Customer Domain Energy Services Interface (ESI)
154   Requirements
155 • Energy Interoperation Version 1.0 - © OASIS® 2010
156 • Smart Grid Communication Standards for Demand Response Data Requirements – (IRC) ISO/RTO Council
157   for PAP09
158 • Transactional Energy Market Information Exchange (TeMIX) An Information Model for Energy Transactions
159   in the Smart Grid - By Edward G. Cazalet, PhD on behalf of the OASIS Energy Market Information
160   Exchange Technical Committee

161

162 The work of OpenADR SRS is dependent upon the best practices available from the following entities and
163 standards organizations:

164

165 • IETF Internet Suite - Internet Standards, including the following
166   • [RFC-793] IETF Transmission Control Protocol (TCP)
167   • [RFC-791] IETF Internet Protocol (IP)
168   • [RFC-2616] Hypertext Transfer Protocol -- HTTP/1.1
169 • [IEC-61968] IEC TC57 Working Group 14 (IEC 61968) (Common Information Model)
170 • [ASAP-SG-3P] Security Profile for Third Party Access (ASAP-SG)
171 • W3C XML, XML Schema related standards
172 • OASIS Web Services related standards

173 1.4.1   RFC 2119 Keyword interpretation

174 The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT",
175 "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119.

1.5   Document Overview

176

177 TOGAF 9.0 defines four architecture domains that are commonly accepted as subsets of overall enterprise
178 architecture, all of which TOGAF is designed to support, see Figure :

179 • **Architecture Vision** defines overall architecture guiding principles, goals and objectives and desired traits.

180 • The **Business Architecture** defines the business strategy, governance, organization, and key business
181   processes.

182 • The **Information Systems Architecture**, including the following.

183 o The **Data Architecture** describes the structure of an organization's logical and physical data assets and
184   data management resources.

185 o The **Application Architecture** provides a blueprint for the individual application systems to be deployed,
186   their interactions, and their relationships to the core business processes of the organization.

187 • The **Technology Architecture** describes the logical software and hardware capabilities that are required to
188   support the deployment of business, data, and application services. This includes IT infrastructure,
189   middleware, networks, communications, processing, standards, etc.
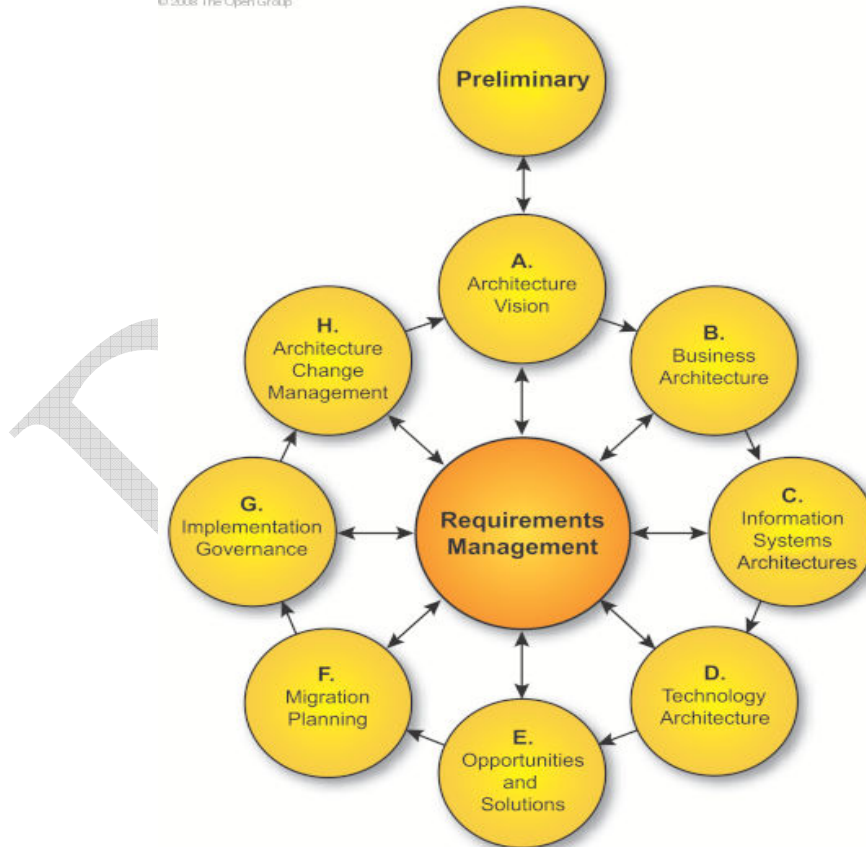

190
191   **Figure 1.   The Open Group Architecture Framework (TOGAF) architecture development cycle.**

192
193 As such, the document will be structured as follows:

194
195 **Section 2** describes the overall Architecture Vision for the system, including Guiding Principles, Architectural
196 Considerations, and the OpenADR Reference Model, all relevant to providing a consistent framework within
197 which the four architecture components can be developed.
198
199 **Section 3** provides details on the following:
200   1. **Business Architecture:** This will refer to work products produced by the Use Case and Service
201   Definition Teams of OpenADR, which includes the list of use cases and integration requirements and
202   business services at the functional level.
203   2. **Data Architecture:** This provides the technical level requirements relative to how the OpenADR data
204   should be modeled and represented consistently across all integration services to ensure semantic
205   interoperability.
206   3. **Application Architecture:** This provides the technical level requirements relative to how applications are
207   modeled as logical components, and what services each logical component may provide or consume. This
208   should be an instantiation of the business services identified within the Business Architecture.
209   4. **Technology Architecture**: This provides the technical level requirements relative to how services will
210   interact with each other to support end-to-end AMI business processes.
211
212 **Section 4** contains the Appendices, which includes terms and definitions, logical components list, integration
213 requirements list, and integration services view.

214 2   Architecture Vision

215 The Architecture Vision articulates the Architectural Goals and Principles that enables the business goals and addresses the
216 stakeholder concerns and objectives. As stated in the Introduction, the goal is the development of open and interoperable
217 Demand Response solutions.

218

219 Demand Response systems consist of the hardware, software and associated system and data management applications that
220 create a communications network between end systems at customer premises (including meters, gateways, and other
221 equipment) and diverse business and operational systems of utilities and third parties, see Figure 2.

222 The Demand Response system components are defined as part of the Systems Architecture later in this document. The
223 components in Figure 2 show the controlling components the Utility Enterprise and Operational Systems that communicate
224 with the Assets and Resources of the Customer through public or private networks.

225
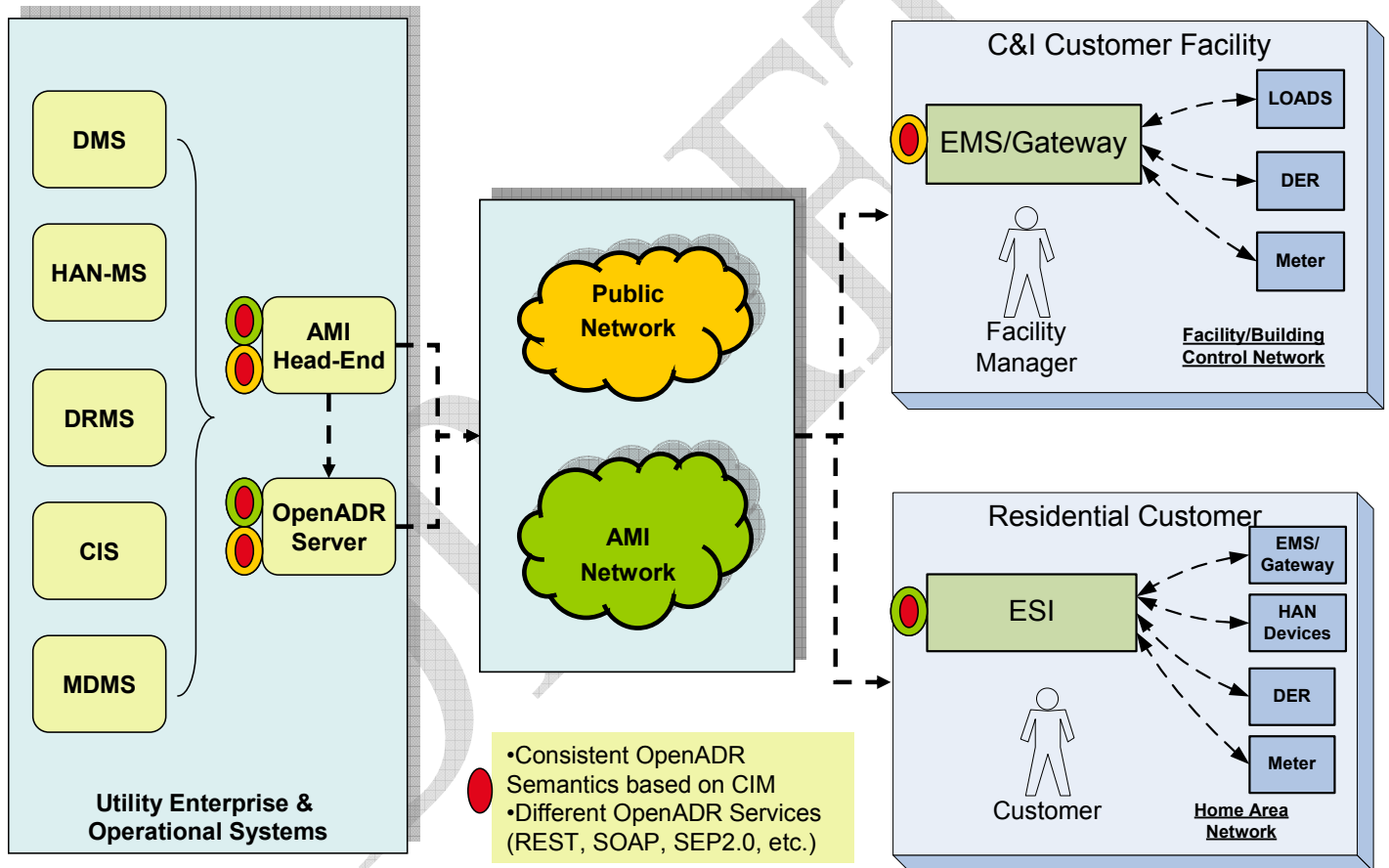
226 **Figure 2. OpenADR SRS component diagram showing the actors and components.**

Components	Description / Key Business Functions
Energy Management System	A system that helps a customer to manage their energy usage within a facility.
Energy Service Interface	Energy System Interface; Energy Services Interface Provides communications, security and, often, coordination functions that enable secure interactions between relevant Home Area Network Devices and the Utility. Permits applications such as remote load control, monitoring and control of distributed generation, in home display of customer usage, reading of additional

Components	Description / Key Business Functions
	meters (e.g. water, gas, renewables, PEVs), and integration with building management systems. Also provides auditing/logging functions that record transactions to and from Home Area Networking Devices. The ESI is assumed to have at least two interfaces: one which provides connectivity to the Home Area Network, and one which provided connectivity to the utility. (ZigBee Smart Energy Profile™ 2.0 Technical Requirements Document)
Distribution Management System	A system that manages the distribution network operations.
HAN Management System	A system that allows utilities to send messages (such as pricing, billing, usage or alarms) to customer display devices (IHDs). Manages the enrollment of devices in specific home area networks, management the enrollment of those devices in programs, manages the de-enrollment in programs and from the HAN
Demand Response Management	A system that manages the demand response programs from utility point of view. Includes load control, integration with DMS, and DR program management. Uses historical and externally input data to make predictions and what-if analysis for DR purposes
Customer Information System	A system that manages customer interaction, billing and issues resolution.

227

2.1 Architectural Goals and Guiding Principles

228

229 Architecture guiding principles are rules of engagement designed to ensure that all aspects of the implementation
230 fit within a well-defined framework. These principles, discussed and agreed upon with all stakeholders of the
231 OpenADR, are used to drive the architectural approach and patterns to be implemented. These principles should
232 not be taken lightly as they imply what and how the overall goals of OpenADR will be met. Each of the
233 principles has a level of effort and cost implications for utilities and 3rd Parties looking to adopt this specification.
234 Adherence to these principles can be adjusted for specific cases driven by time and budget constraints. These
235 exceptions should be approved by all stakeholders and must be documented.

236 - Exchanges of data cross enterprise boundaries
237   - o Industry best practices must be followed
238   - o The most interoperable and widely supported technologies should be used to ensure adoption
239   regardless of development and deployment platforms used
240   - o The technologies chosen shall be well specified, with active communities and tools and/or
241   frameworks available. For example, WS-I, or RESTful in conjunction with AtomPub, OData or
242   GData.
243   - o Technologies chosen shall be compatible and interoperable with technologies specified for access
244   to on premise or HAN resources.
245   - o Security and privacy of customer information is of utmost importance, since transfers must
246   support the secure use of public networks, and sensitive customer information may be exchanged
247   across enterprise boundaries.

248 - Recommendations must promote and enable interoperability
249   - o Many utilities need to be interoperable with many 3rd Parties, so there are significant efficiency
250   savings possible by defining a common interface for the OpenADR message exchanges.
251   Therefore, recommendations must be specific and prescriptive, actionable and testable

252 - Must meet the goals of several different types of stakeholders
253   - o Requires an open process to allow discussion and negotiation of the recommendation

254 - Forwards and backwards version compatibility is needed
255   - o Existing implementations must remain operational when either side adds future extensions

2.2 Architectural Considerations

256

257 OpenADR as a system needs to be architected with requirements that cover the entire spectrum of business,
258 technical, and market needs. The following list of architectural attributes will be used as guidelines for OpenADR
259 systems requirements development.

260 - System quality attributes discernable at runtime
261   - o Performance - Services SHALL provide and consume data in a timely manner as defined by the
262   requirements.
263   - o Security –

---

264   • Parties involved in any DR event SHALL be authenticated and authorized;

265   • Command/message exchanged between parties involved in any DR event SHALL be
266   secure from end to end.

267   • Results of the DR event execution SHALL be auditable.

268   o Authorization – Protected resources SHALL be authorized individually by the user(s) associated
269   with those resources.

270   o Availability – Services SHALL be highly available as defined by the requirements.

271   o Functionality – SHALL meet the functional needs of customers and regulators

272   o Usability – SHALL require only commonly available tools and technologies

273   o Scalability – SHALL be able to add additional servers to meet performance

274   • System quality attributes requiring assessment for evaluation

275   o Modifiability – SHALL allow additions without affecting existing systems

276   o Portability – SHALL be possible to implement on a variety of platforms

277   o Reusability – SHALL use standard industry object representations

278   o Integrability – SHALL be possible to map to a variety of other interfaces

279   o Testability – SHALL be possible to perform testing using a variety of methods

280   • Business Qualities

281   o Cost – SHALL not be cost-prohibitive

282   o Projected life time of the system – SHALL allow growth

283   • Qualities directly related to the architecture

284   o Conceptual integrity – Semantics of defined elements SHALL be consistent across objects that
285   use those elements

286   o Correctness and completeness - Is aligned with common application architectures and addresses
287   all considerations required for interoperability.

288 Note that desired, minimum and maximum levels for performance, availability, functionality, acceptable use, and
289 other characteristics will likely be specified and negotiated in Service Level Agreements (SLAs) between DL
290 Signal consumers and providers. Regulators may also require certain service levels. Each side will likely have
291 some number of terms required for use of their services. This is not part of the standardization effort, just a note to
292 prepare for these agreements.

293 # 3 OpenADR Systems Architecture

294 ## 3.1 OpenADR Business Architecture View

295 The key stakeholders to be addressed by the business architecture are shown in the figure below. The stakeholders all
296 perform business roles and represent a subset of the Actors from the use cases which fill business roles in the OpenADR
297 business processes, as described in the *DR Functional Requirements and Use Case Document*.
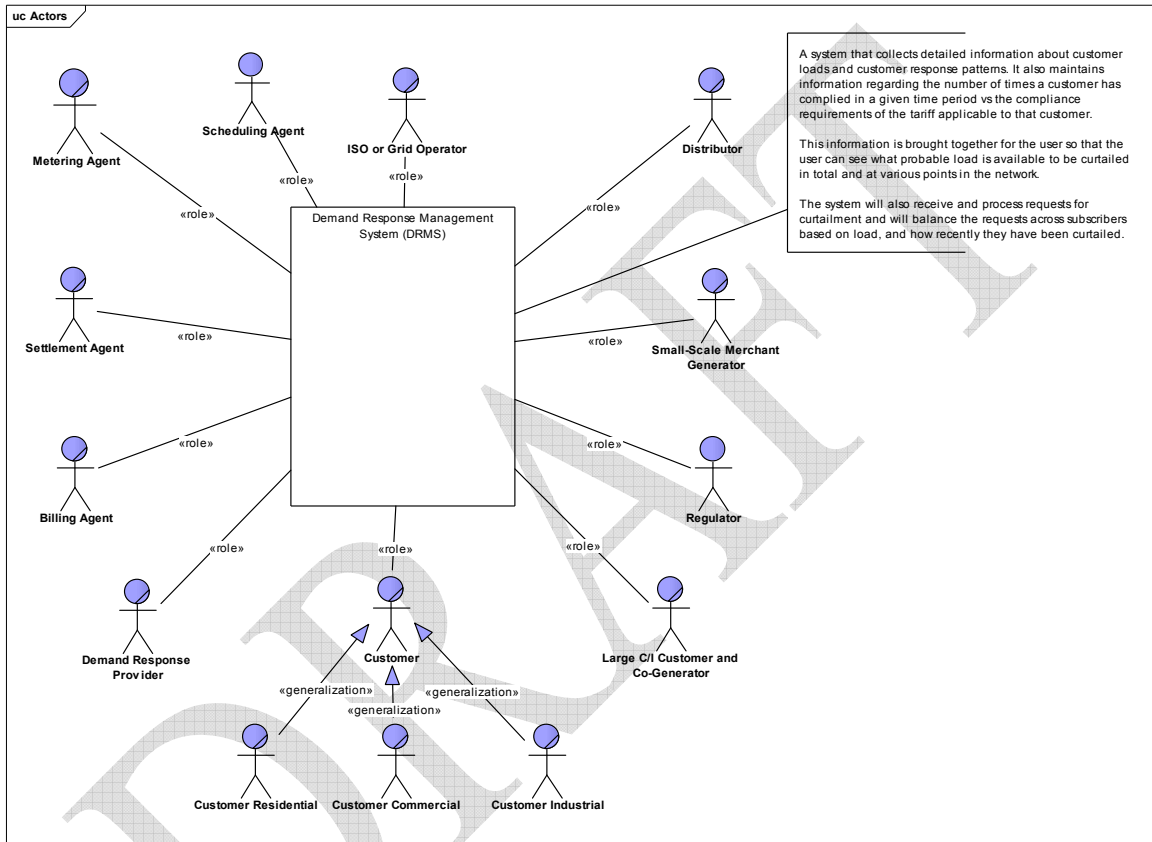
298

299 **Figure 1. OpenADR Stakeholders Overview**

300

301

302 The primary business flows include DR Program Administration, Bidding, and Execution as shown in the
303 following diagram. The swim lanes represent business roles and the blocks within the swim lanes correspond to a
304 business process carried out by that business role. Business roles are related to the Actors identified earlier;
305 however, in some cases multiple different Actors may carry out the same business role. For example, an ISO/RTO,
306 Utility Distribution Company (UDC), Load Serving Entity, or DR Aggregator can all perform the business role of
307 Controlling Entity. The business processes shown are those that involve the exchange of information between
308 business roles.

309

310

311
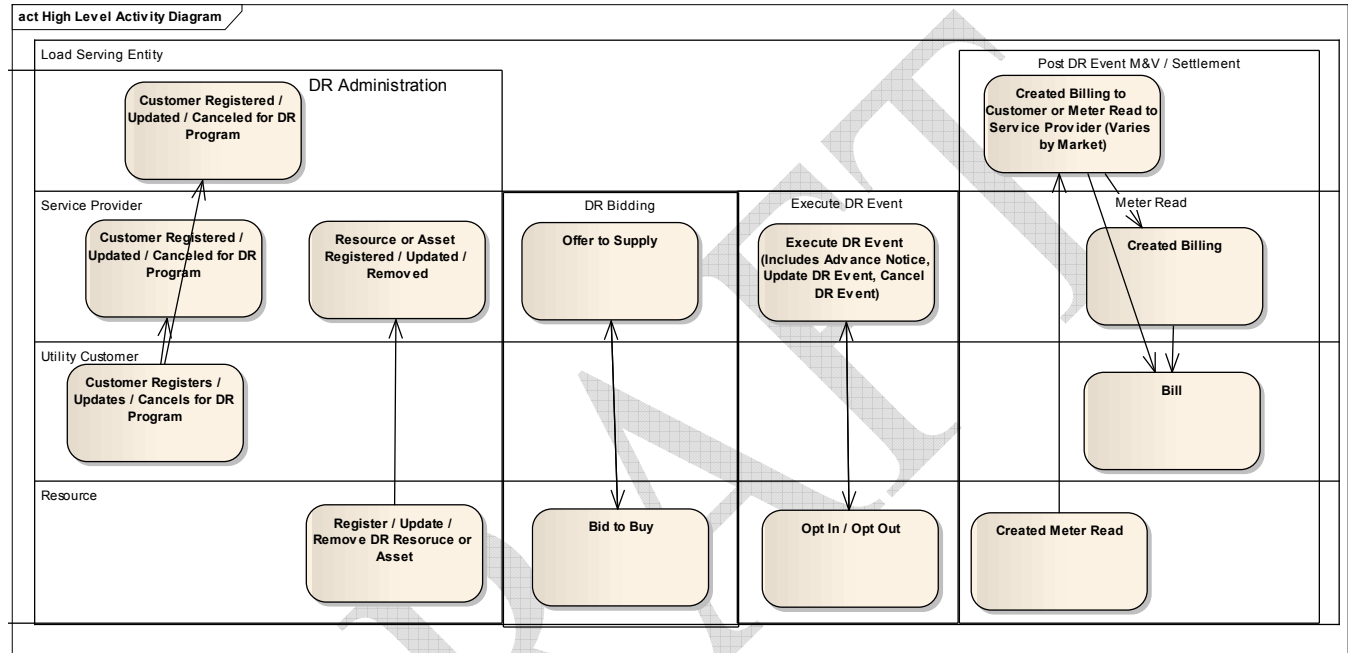
Figure 2. Overview of Business Process Flows

313 The Business Roles used in the Business Process Flow shown in Figure 4 are summarized from the Use Cases and
314 represent activities performed at the business level. Section 3.2.2 Functional Requirements – Integration Services
315 maps these business roles into integration roles as described in that section.

316 The Demand Response process flow is broken into four phases: DR Administration, DR Bidding, Execute DR
317 Event, and Post DR Event Measurement and Verification / Settlement. The DR Execution processes includes DR
318 Program types of Direct Load Control, Dynamic Price Based / Real Time Pricing, and Notification (Objectives)
319 Based.

320 **Following is a table listing all major Business Roles that will provide some functions to support ADR**
321 **business processes.**

Business Role	Description / Key Business Functions	Map to NIST	Map to LBNL
Load Serving Entity	A role which carries the responsibility of serving end-users and selling electric energy to end-users. (PAP09 Retail dated 2/11/2010 v 1.5) The entity that is responsible for serving the Electricity Customers Electricity needs. An LSE may also perform the role of DR Aggregator. (Base Use Case)	Load Serving Entity	
Electricity Consumer	The end users of electricity. May also generate, store, and manage the use of energy. Traditionally, three customer types are discussed, each with its own domain: home, commercial/building, and industrial.	Utility Customer	Participant
Service Provider	A role which carries the responsibility of coordinating resources to deliver electricity products and services to a market or distribution operator.	Service Provider	
Demand Response Provider (DRP)	An entity or role with the responsibility to coordinate demand resources to deliver demand response services. A DRP includes entities that have acquired curtailment rights from electricity consumers, and manage the aggregation of capacity that is curtailable as an eligible energy or capacity resource for participating in Demand Response programs. (PAP09 Retail dated 2/11/2010 v 1.5)		
DR Controlling Entity	This is a generalized actor class and represents all the different entities that may need to manage and interact with wholesale and/or retail DR resources. It includes the following actors: ISO/RTO, Distribution Company, Load Serving Entity, DR Aggregator. (PAP09 Retail dated 2/11/2010 v 1.5)		DRAS - Demand Response Automation Server
DR Asset	An energy resource that is capable of shedding load in response to Demand Response Events, Electricity Price Signals or other system events (e.g. under frequency detection). Examples of Demand Response Assets are: Smart Appliances, entire buildings that are under the control of an Energy Management System, Electric Vehicles. (PAP09 Retail dated 2/11/2010 v 1.5)		
DR Resource	A DR resource is a virtual representation of one or more DR assets. It is similar to a DR Asset in that it is capable of shedding load in response to a triggering event. Unlike a DR Asset, which is autonomous, a DR Resource may consist of multiple DR Assets that have been aggregated to form a larger capacity or energy resource. An apartment building with multiple electricity		DRAS Client

Business Role	Description / Key Business Functions	Map to NIST	Map to LBNL
	consumers, each one having one or more DR Assets may be considered one large DR Resource by aggregating the total load shedding capacity of all the DR Assets in the apartment building and representing the sum total of this capacity as one DR Resource. A DR Resource may also consist of different types of Assets (e.g., a wind Turbine and an electric motor that work in combination to meet DR program obligations). (PAP09 Retail dated 2/11/2010 v 1.5)		
System and Market Operator	A System Operator is a Balancing Authority, Transmission Operator, or Reliability Coordinator whose responsibility is to monitor and control an electric system in real time (based on NERC definition). The System Operator is responsible for initiating Demand Response Events (e.g., Advance Notifications, Deployment, and Release/Recall instructions). The Market Operator manages the bulk electricity market and produces prices for various products. ISO New England and PJM Interconnection are examples of Market and System Operators that perform this function. (PAP09 Retail dated 2/11/2010 v 1.5)		

322

3.2 Integration Requirements Specification

3.2.1 Functional Requirements – Business Processes

The business processes that have been developed as part of OpenADR are listed as follows. Note that the requirements documents summarized in section 1.4 External Considerations and References contain the details of each business process (use case).

The following requirements are identified based the use cases defined in *Requirements Specifications for Retail Standard DR Signals - for NIST PAP09.*

- Administrate Customer for DR (Limited to data required to support DR Signals)
  - Register / Enroll Customer for DR Program
  - Remove Customer from DR Program

- Administrate DR Resource (Limited to data required to support DR Signals)
  - Administrate Distribution DR Resource
  - Update DR Resource
  - Register DR Resource

- Administrate DR Asset (Direct Load Control)
  - Register DR Asset
  - Update DR Asset
  - Remove DR Asset

- DR Bidding
  - DR Bid to Supply (Retail Offers)
  - DR Bid to Buy

- Execute DR Event
  - Notify DR Event
    - Advanced Notification for DR
    - Update a DR Event
    - Cancel a DR Event
    - DR Resource Confirmation
  - Dispatch DR Objectives

351   o   DR Direct Load Control

352   ▪   Monitor DR Event (DR Resource)

353   ▪   Monitor DR Event (DR Asset)

354   o   DR Real Time Pricing (RTP)

355   o   Operational Coordination

356   ▪   Post DR Event Management (out of scope, handled by other groups: AMI-ENT and
357   M&V Settlement Standards)

358   ▪   Post DR Event M&V / Settlement (No Open Retail)

359   ▪   Post DR Event M&V / Settlement (Open Retail)

360   ## 3.2.2   Functional Requirements – Integration Services

361   ### 3.2.2.1 Logical Components

362   Logical Components are used in this document to organize interfaces (integration services) for OpenADR. These
363   logical components represent IT systems which exchange information to carry out the business processes and
364   implement the use cases identified earlier. They may be mapped to specific physical components for a particular
365   implementation. The Logical Components in some cases consolidate multiple Business Roles/Actors to represent
366   entities which perform a common integration role in exchanging information. For example, a DR Controlling
367   Entity is a generalized actor class which represents all the different entities that may need to manage and interact
368   with wholesale and/or retail DR resources. It represents actors such as an ISO/RTO, Distribution Company, Load
369   Serving Entity, and DR Aggregator.

370   Following is a table listing all major logical components that will provide some functions to support ADR
371   business processes. All services will be organized accordingly.

Logical Components	Description / Key Business Functions	Map to NIST	Map to LBNL
Electricity Consumer	The end users of electricity. May also generate, store, and manage the use of energy. Traditionally, three customer types are discussed, each with its own domain: home, commercial/building, and industrial.	Utility Customer	Participant
DR Asset Owner	The entity that is responsible for the DR Resource or Asset in the retail market.		
DR Controlling Entity	This is a generalized actor class and represents all the different entities that may need to manage and interact with wholesale and/or retail DR resources. It includes the following actors: ISO/RTO, Distribution Company, Load Serving Entity, DR Aggregator. (PAP09 Retail dated 2/11/2010 v 1.5)		
DR Asset	An energy resource that is capable of shedding load in response to Demand Response Events, Electricity Price Signals or other system events (e.g. under frequency detection). Examples of Demand Response Assets are: Smart Appliances, entire buildings that are under the control of an Energy Management System, Electric Vehicles. (PAP09 Retail dated 2/11/2010 v 1.5)		
DR Resource	A DR resource is a virtual representation of one or more DR assets. It is similar to a DR Asset in that it is capable of shedding load in response to a triggering event. Unlike a DR Asset, which is autonomous, a DR Resource may consist of multiple DR Assets that have been aggregated to form a larger capacity or energy resource. An apartment building with multiple electricity consumers, each one having one or more DR Assets may be considered one large DR Resource by aggregating the total load shedding capacity of all the DR Assets in the apartment building and		

Logical Components	Description / Key Business Functions	Map to NIST	Map to LBNL
	representing the sum total of this capacity as one DR Resource. A DR Resource may also consist of different types of Assets (e.g., a wind Turbine and an electric motor that work in combination to meet DR program obligations). (PAP09 Retail dated 2/11/2010 v 1.5)		
System and Market Operator	A System Operator is a Balancing Authority, Transmission Operator, or Reliability Coordinator whose responsibility is to monitor and control an electric system in real time (based on NERC definition). The System Operator is responsible for initiating Demand Response Events (e.g., Advance Notifications, Deployment, and Release/Recall instructions). The Market Operator manages the bulk electricity market and produces prices for various products. ISO New England and PJM Interconnection are examples of Market and System Operators that perform this function. (PAP09 Retail dated 2/11/2010 v 1.5)		

372   The following figure represents the Business Process Flows consolidated using the Logical Components.
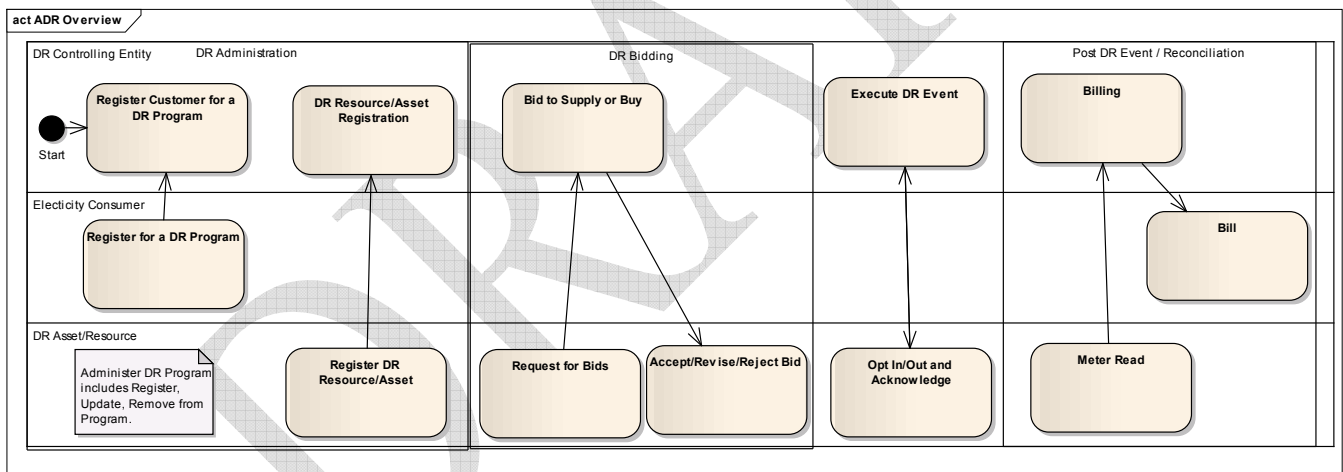
373

374   **Figure 5. Overview of Business Process Flows Using Logical Components.**

375   The following diagram shows the logical components involved in data exchanges. The exchanges are identified at
376   a high level in order to show the major types of functions carried out.
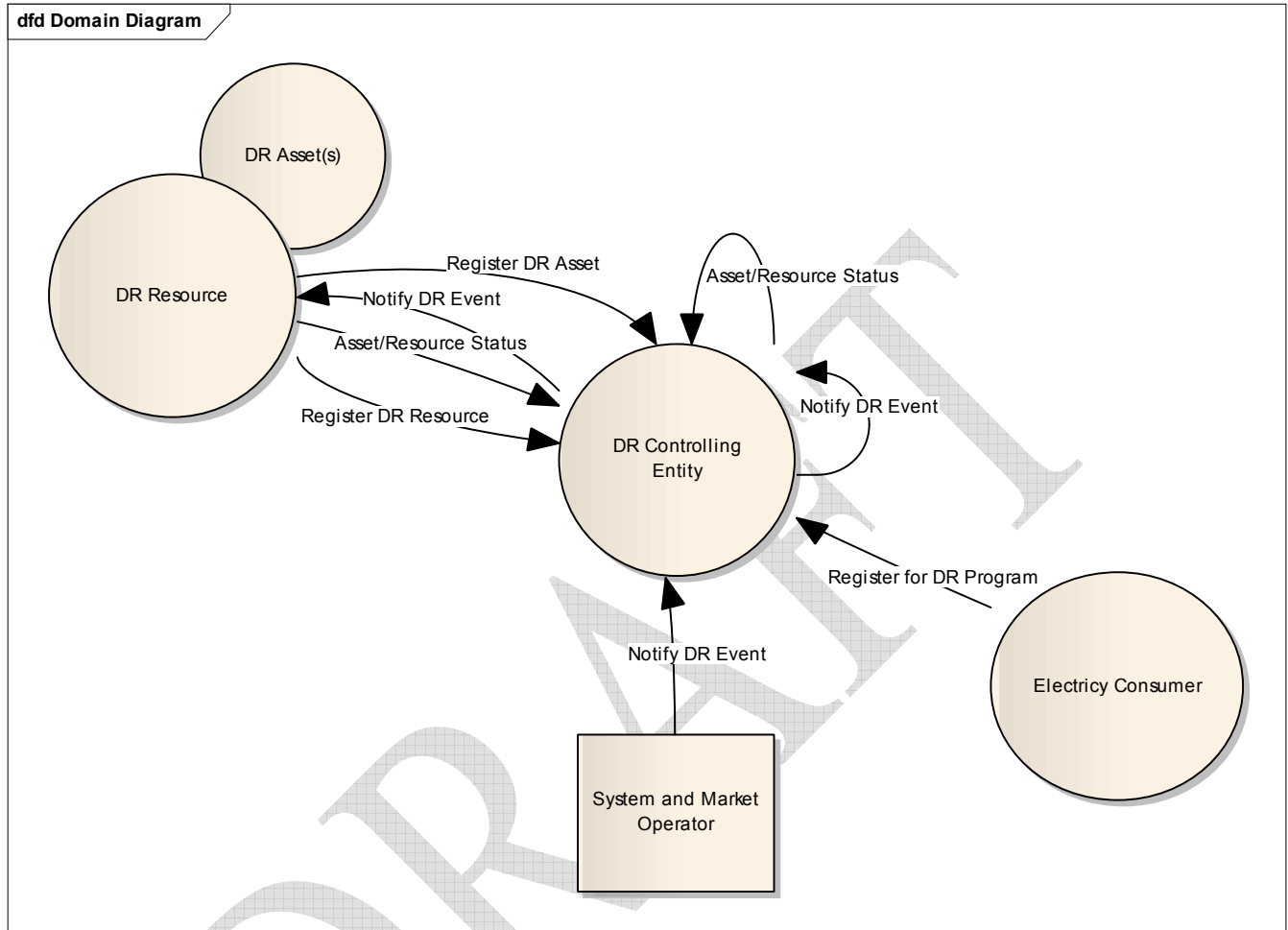
377

378   **Figure 6. Overview diagram of Logical Components**

379
380   Note that a DR Controlling Entity may represent a single Actor, such as a Utility Distribution Company in the
381   business role of a Load Serving Entity. However, a DR Controlling Entity may also represent a hierarchy of
382   entities, such as an ISO/RTO dispatching DR instructions to a Transmission Operator, who in turn sends the
383   dispatch instructions on to a UDC, who sends instructions to a DR Aggregator, who then directs a specific DR
384   Resource to execute the instruction. This can be modeled as a recursive relationship with DR Controlling Entity
385   which represents each of these Actors in an integration role. The goal is to minimize the number of different
386   logical components and hence the number of different services and message payloads that need to be defined
387   through reuse of the standard services and payload definitions.
388
389   This concept is elaborated more extensively in a recent EPRI report titled *Concepts to Enable Advancement of*
390   *Distributed Energy Resources.* This approach is made possible as we shift from designing *control* systems which
391   issue direct load controls to system viewed as a grid resource which "has the ability to handle to handle a situation

392 in an effective manner"[3], where the "how" of the response is replaced by a description of the situation requiring a
393 change in energy consumption, leaving it to the final DR Resource to know how to control DR Assets to effect the
394 desired change in energy use. The concept put forward by the EPRI report is called the REC-VEN concept, where
395 the REC (Resource Energy Controller) determines when and why to send specific grid messages to the resources
396 it manages, which are represented as a VEN (Virtual End Node). A VEN can in turn also function as a REC to
397 another VEN which is lower down in the control hierarchy.
398
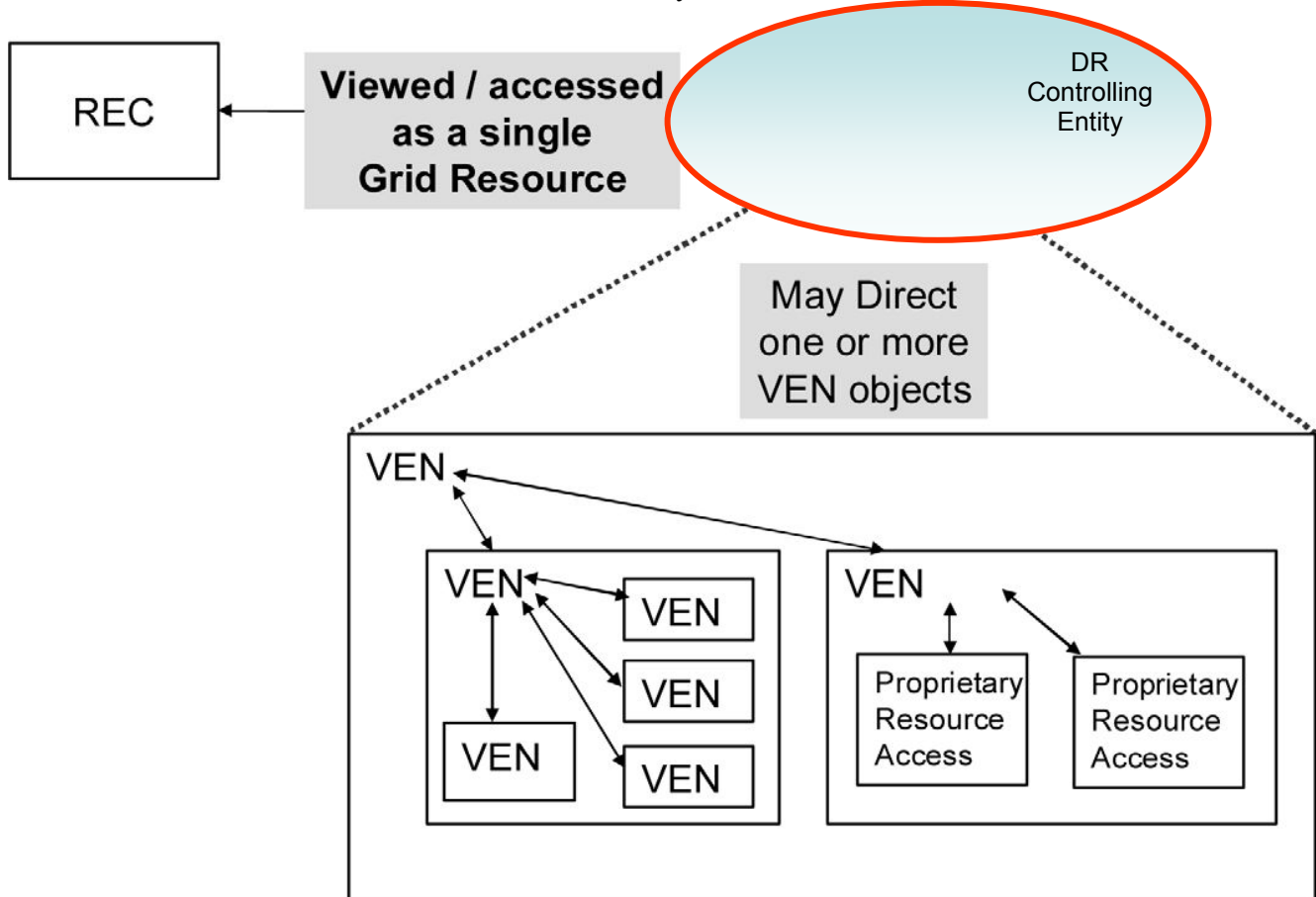
399
400 **Figure 7. REC-VEN Operations [3]**
401
402 In the diagram above, the DR Controlling Entity can be thought of as a VEN-REC object, thus representing all the
403 entities in series from the System and Market Operator to the DR Resource. This is modeled by adding a recursive
404 relation to a DR Controlling Entities, so that the DR Controlling Entity in the diagram represents one or more
405 entities. This approach ensures a scalable architecture for all future Smart Grid developments.

---

[3] *Concepts to Enable Advancement of Distributed Energy Resources: White Paper on DER*. EPRI, Palo Alto, CA : 2010. 1020432.

406   3.2.2.2 Integration Services

407   The following Integration Services were derived from the Use Cases, Business Processes, and Functional
408   Specifications documents defined earlier (Section 3.2.1) and represent the services needed to carry out the
409   necessary data exchanges between logical components. The data required for the data exchange is defined in
410   Section 3.4.1 Data Architecture View.

411

412   Specific Service Operations and Resource Patterns are defined as part of the OpenADR Service Definition
413   document and the associated artifacts. The operations are defined based on the methods defined in Section 3.4
414   OpenADR Data Architecture View.

415

416   A detailed list of individual messages in Use Case Context is provided in Section 4.2.

417

Use Case Scenario	Service Name	Provider	Functional Description of the Service	Priority
Administrate Customer for DR	DR Customer Agreement	DR Controlling Entity	Customer is Registered for, Updated or Removed from a DR Program.	3
Administrate DR Resource	DR Resource	DR Resource Owner	DR Resource is registered and associated with a DR Program and Customer. The Resource is updated and/or removed from DR Program.	2
Administrate DR Asset	DR Asset	DR Asset Owner	DR Asset is registered and associated with a DR Resource. The Resource is updated and/or removed from DR Program.	2
Execute DR Event	Notify DR Event	DR Controlling Entity	DR Event information is sent to participants prior to the DR Event start based on defined intervals and is Updated, and/or Canceled.	1
Execute DR Event	DR Event	DR Controlling Entity	DR Event is a polymorphic message type that supports Direct Load Control, DR Instructions (Objectives), Price Schedule	1
Execute DR Event – Operational Coordination	Forecast Demand	DR Controlling Entity	Multiple levels of aggregated DR Demand and Telemetry data is provided for the purpose of coordinating a DR Event and to provide checks against circuit limits.	6
Execute DR - Event Monitoring / Confirmation	Asset / Resource Status (State)	DR Resource or Asset	The DR Resource or Asset (in the event of DLC) provides status for opt in / out or other state that impacts Demand Response. The Status message may be as a confirmation reply to a DR Signal or as an update resulting from a state/status change or in response to a Get message.	1
Post DR Event – M&V / Settlement	Meter Read & Billing		The process and messages used for settlement of a DR event are the same as defined in the *Utility AMI AMI-ENT System Requirements Specification*, Utility AMI-ENT Task Force. The meter read interval is determined by the interval of DR Event participation.	4
DR Bidding				5

418

419

420 ### 3.2.3 Technical Requirements – Integration Services

421

422 Integration services that are well defined, understood and managed are the linchpin of an open and interoperable
423 implementation between the utility enterprise and other business entities. Following is a list of guiding principles
424 for integration services design:

425 • Common protocol and business semantics SHALL be used to achieve loose coupling of end-point service
426 (directly or indirectly)

427 • Services SHALL be representative of a unique unit of work and reusable across business functions.

428 • Services SHALL be reusable across common practices of utilities.

429 • Service design SHALL be driven by business requirements and reflected in the architecture.

430 • Service design SHALL be governed with a common approach and framework to achieve conceptual
431 integrity.

432 • Service level agreement should be defined to support key architecture qualities: security, reliability,
433 performance, availability, scalability, data quality, information fidelity, etc.

434 ## 3.3 OpenADR Application Architecture View

435 1. Audit information SHOULD be maintained, so that a report could be produced containing details (who,
436 what, when, etc.) about authorizations, transfers, and other significant events.

437 2. OpenADR Application Architecture SHALL provide measures that protect and defend information and
438 information systems by ensuring their availability, integrity, authentication, confidentiality, and non-
439 repudiation.

3.4 OpenADR Data Architecture View

Based on OpenADR use cases, the following data objects have been identified. The OpenADR services SHALL implement methods to make requests related to these objects.

- DR Customer Enrollment
    - o Register Customer for DR Program
    - o Update Customer for DR Program
    - o Remove Customer from DR Program
- DR Asset (End Device)
    - o Register Asset for DR Program
    - o Update Asset for DR Program
    - o Remove Asset from DR Program
- DR Resource (Device Group)
    - o Register Resource for DR Program
    - o Update Resource for DR Program
    - o Remove Resource from DR Program
- Notify Demand Response Event
    - o Advance Notification
    - o Update Event
    - o Cancel Event
- Demand Response Event
    - o Types:
        - ▪ Direct Load Control Signal
        - ▪ Demand Response Instructions / Objectives (DR Dispatch)
        - ▪ Price Signal / Schedule
    - o Updates
    - o Cancel
- Forecast Demand (out of scope)
- Asset / Resource Status (Monitor Demand Response Event)
    - o Response to Signal
    - o Get Status/State
    - o Continuous Response

472   3.4.1   Temporal Model of a DR Event

473   An Event consists of the time periods, deadlines, and transitions during which Demand Resources perform. A DR Event
474   Schedule a Notification Period, Active Event Period, Ramp Period and Recovery Period. The Ramp Period is considered part
475   of the Active Event Period. A DR Event can be partitioned into a continuous block of consecutive time periods called
476   intervals. Events can also be open-ended. i.e. a Start Time without duration or end-time.

477   An instance of DR instructions represents a specific type of instruction that was defined specifically for the DR program and
478   is effective for a specific interval or open-ended. Each type of instruction may have a schedule of values that are valid across
479   the entire period for which the DR event is active. Therefore, a single type of instruction may have multiple values, each of
480   which are valid during a different time period during the event.

481   The Temporal Model of a DR Event is shown in Figure 8 below (Based upon OpenADR model).

482
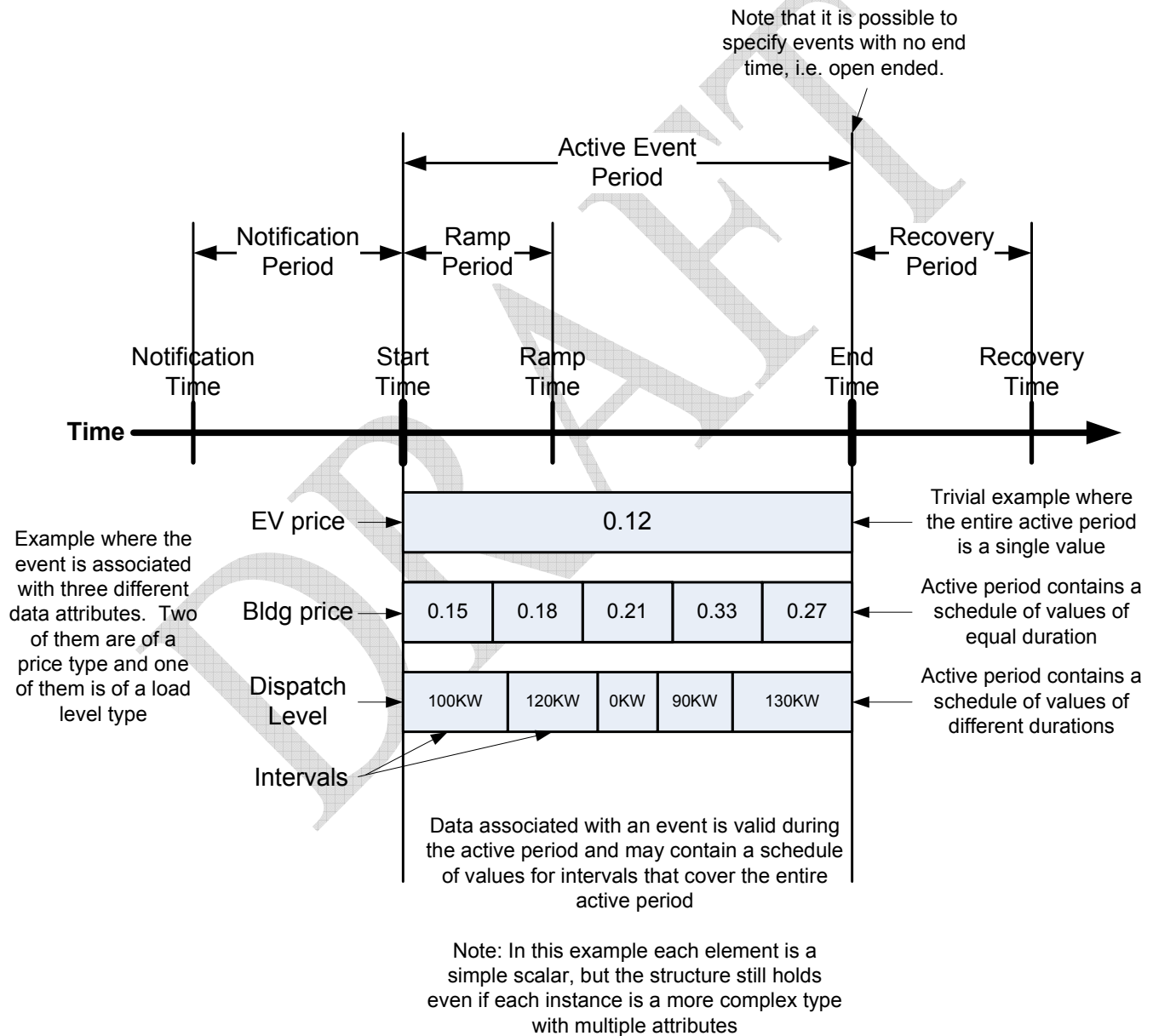
483   **Figure 8. Temporal Model of a DR Event and its Associated Data**

484

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485

3.4.2 DR Event - Data Requirements

A DR Event data object is used to initiate a DR Dispatch types of Price Plus, Objectives, and Direct Load Control. An Event consists of the time periods, deadlines, and transitions during which Demand Resources perform. (PAP09 Wholesale)		Map To			
Data Element	**Description**	**PAP09 Retail**	**PAP09 Wholesale**	**OADRCS[4]**	**Map to SEP 2.0 TRD**
All DR Events					
DR Program Name	An identifier of the program for which a DR event was issued.	DR Program Name		UtilityProgram.name	DR event name
Service Provider ID	An identifier for the Service Provider issuing the DR event.	Service Provider ID			
Event ID	An identifier for the DR event that was created when the DR event was first issued.	Event ID		eventIdentifier	DR event ID
Event Modification Number	A modification number for the DR event. This is used to indicate if the DR Event has been modified by the Utility. Each time it is modified, this number is incremented.	Event Modification Number		eventModNumber	
Test Event Flag	This attribute signifies whether this is a test event or not. Test events may be issued by the Utility/ISO like other DR Events.	Test Event Flag			
All Price Plus Information Dispatches					
DR Dispatch Type	Identifies the type of the DR Price Plus Dispatch. PRICE_ABSOLUTE - Price number PRICE_RELATIVE - Change in price PRICE_MULTIPLE - Multiple of current price	Instruction Type			
All Price Plus Information Intervals					
Currency	Identifier used to interpret the price element. MUST follow ISO 4217 standard.	Currency			
Price	Expressed in decimal notation with a precision up to 6 decimal places. Prices MAY be either positive or negative. Single or multiple valued price (e.g., for energy, demand, etc.)	Price			

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[4] Abbreviation for *OPEN AUTOMATED DEMAND RESPONSE COMMUNICATIONS SPECIFICATION*

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A DR Event data object is used to initiate a DR Dispatch types of Price Plus, Objectives, and Direct Load Control.
An Event consists of the time periods, deadlines, and transitions during which Demand Resources perform. (PAP09 Wholesale)

Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS[4]	Map to SEP 2.0 TRD
Unit-of-Measure	Indicates the unit of measure for which the price pertains. MUST be complaint with the International System of Units as defined by NIST SP 330, ref: http://physics.nist.gov/Pubs/SP330/sp330.pdf Examples of NIST compliant units of measure include: kWh MWh	Unit-of-Measure		Unit-of-Measure	
Duration	The amount of time for which this price is valid, commencing at the Effective-Date-Time specified. A value of zero means price is valid until next price broadcast override. Specified in decimal notation where integers represent minutes and decimals represent fractions of minutes.	Duration		duration	
Effective-Date-Time	The date and time which the price is in effect. In ISO 8601 standard format. The date and time interval which the price is in effect.	Effective-Date-Time			
Location Identifier	An identifier used to indicate an area which this price is in effect. A value of "null" indicates that the price is in effect for all areas.	Location			
Location-type	A value used to interpret the value contained in the Location element. Examples of Location-type include: Address Zone GPS Coordinates Grid Location / USNG Electrical Node Zip-code	Location-type			
Product Type	Identifies the type of product to which this price pertains. Contains an enumeration of various products that may be offered. Extensibility MUST be supported in order to accommodate multiple jurisdictions and markets. Product types include the following: energy, regulation, spinning reserve.	Product-Identifier			

A DR Event data object is used to initiate a DR Dispatch types of Price Plus, Objectives, and Direct Load Control.
An Event consists of the time periods, deadlines, and transitions during which Demand Resources perform. (PAP09 Wholesale)

Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS[4]	Map to SEP 2.0 TRD
	All DR Objective Dispatches				
DR Dispatch Type	Identifies the type of DR Objectives: • LOAD_LEVEL • LOAD_AMOUNT • LOAD_PERCENTAGE	Dispatch Instructions		EventInfoTypeID EventInfoValue	
	All DR Objective Intervals				
Interval Start Time	Start time of the dispatch interval.	Event Schedule	Event Day Event Start Time Event End Time	EventInfoInstance .Values .value .startTime	
Interval Duration	Period of time the Control Command is in effect.				
	All DR Load Level Objective Intervals				
Load Level Value	Value of the load level to be achieved based on a set of enumerated values.				
	All Load Amount Level Objective Intervals				
Load Amount Value	Fixed amount of load to shed in kW.				
	All Load Percentage Objective Intervals				
Load Percent Value	Percentage of load to shed.				
	All Direct Load Control Dispatches				
DR Dispatch Type	Identifies the objective type as Direct Load Control.	DR Dispatch Type			
DR Asset ID	An identifier of the DR Asset for which the control is intended.	DR Asset ID			HAN Device ID
Status Check	A signal to require the DR resource status to be sent back.	Status Check			SEP 2.0 Req[DRLC-3] No specific data requirement
	All Direct Load Control Intervals				

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A DR Event data object is used to initiate a DR Dispatch types of Price Plus, Objectives, and Direct Load Control.
An Event consists of the time periods, deadlines, and transitions during which Demand Resources perform. (PAP09 Wholesale)

Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS[4]	Map to SEP 2.0 TRD
Direct Load Control Type	The type of DR Direct Load Control Command: e.g. Set Point Open/Close Etc.	DR Control Command			
Direct Load Control Value	Value associated with the Direct Load Control Type.	DR Control Command			
Interval Start Time	Start time of the dispatch interval.	Event Schedule		EventInfoInstance .Values .value.startTime	DR event start date/time
Interval Duration	Period of time the Control Command is in effect.				DR event duration

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3.4.3 Notify DR Event - Data Requirements

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Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS[5]	Map to SEP 2.0 TRD
Notify DR Event is an advance notification of a DR Event on a day-ahead or hour-ahead basis. Advance notification-based DR is used for economic purposes and reliability events when the system operator expects a contingency or operating condition (e.g., congestion or planned outage) on the distribution or the transmission grid that requires a reduction (or an increase) on the load at a given location.					
	Notify DR Event includes all of the elements of Event with the following additional elements.				
Event Modification Number .	This is Modification number of the DR event. It is used to indicate that the DR Event has been modified by the Utility. Each time a DR Event is modified, this number is incremented.	Event Modification Number		eventModNumber	
Modification reason code	The reason the event was modified.	Modification reason code		EventState	
Cancellation reason code	The reason the event is being cancelled.	Cancellation reason code			
(Cancel) Effective date/time	The date and time a cancellation takes effect.	(Cancel) Effective date/time			
	PAP09 Wholesale includes attributes for Baseline Calculation and other. ***Out of scope for this release.***				
Baseline Dates	Dates of days used to calculate the Energy Baseline		Baseline Dates		
Baseline Exclusion Dates	Dates of days Excluded from the calculation of the Energy Baseline		Baseline Exclusion Dates		
Energy Baseline Value	Calculated Energy Baseline		Energy Baseline Value		
Energy Baseline Timestamp	Timestamp of Energy Baseline		Energy Baseline Timestamp		
Reporting Interval	Interval size required for Reporting		Reporting Interval		

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3.4.4 Asset / Resource Status (State) – Data Requirements

Asset/Resource Status (State) data object is sent by a DR Resource to a DR Controlling Entity in response to receipt of a DR Event or a Notify DR Event. It is be used as an acknowledgement of the receipt of the DR signal, but it may also contain various information used to signify how the DR Resource will respond to the DR Signal.

Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS[6]	Map to SEP 2.0 TRD
DR Resource ID	The identifier of the DR Resource.	DR Resource ID			
Exception Conditions	This is used to report that the load controller may not behave as commanded because of a variety of conditions including: • Faults in device • Customer override.	Exception Conditions			
Load Control State	The state of the load, which includes both commanded states and user settings. This may include a schedule of future states if a particular control algorithm for the load controller is being executed.	Load Control State		ResponseSchedule	Req[DRLC-3] No specific data requirement
Operational Constraints	Constraints on how the load may be controlled. This may include limits on the state of the load controller as well as schedules upon those constraints.	Operational Constraints			
DR Assets Characteristics	The expected response characteristics of each DR Asset that is part of the DR Resource. These may be needed for aggregated DR Assets and may be as simple as whether a DR Asset is participating or its actual load profile. For each DR Asset, the following should be given: • Location of Asset, either geographic or grid location • Asset schedule of participating Asset load profile (schedule).	DR Assets Characteristics			
DR Resource Load Profile Response	The load profile response characterization of the DR Resource in response to getting the DR signal.	DR Resource Load Profile Response			
Notification Received Acknowledgement	This is an acknowledgement of the receipt of a DR notification or dispatch. It should include any necessary provisions for non-repudiation.	Notification Received Acknowledgement			

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[6] Abbreviation for *OPEN AUTOMATED DEMAND RESPONSE COMMUNICATIONS SPECIFICATION*

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Asset/Resource Status (State) data object is sent by a DR Resource to a DR Controlling Entity in response to receipt of a DR Event or a Notify DR Event. It is be used as an acknowledgement of the receipt of the DR signal, but it may also contain various information used to signify how the DR Resource will respond to the DR Signal.

Data Element	Description	Map To				
		PAP09 Retail	PAP09 Wholesale	OADRCS[6]	Map to SEP 2.0 TRD	
Opt in/out	This is used to temporarily opt in/out of DR Events and to override the normal operational constraints. The opt-in/out can be specified using the following criteria: • All events in a program indefinitely • Specific DR Event • All events in a specific time period. In addition, there may be a schedule associated with the opt in/out state.	Opt in/out		OptOutState	Req[DRLC-1] No specific data requirement	

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3.4.5 DR Resource – Data Requirements

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Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS[7]	Map to SEP 2.0 TRD
A DR Resource is used during the enrollment process. A DR Resource as a logical entity is a group of Assets that represents a dispatchable entity.					
DR Resource Identifier	This identifies the DR Resource that is being registered.	DR Resource Identifier	Resource ID		
Resource Type	Type of Resource. Valid types are: load reduction, generation, combination.		Resource Type		
Resource Qualification Test Date	Date the Resource demonstrated its ability to deliver a product or service		Resource Qualification Test Date		
Requalification Test Date	Date the Resource will retest its ability to deliver a product or service		Requalification Test Date		
Available-Capacity	The total amount of power (megawatts) available from the asset/resource, expressed in integer format representing the amount of kilowatts available.	Available-Capacity			
Customer Identifier	This is a customer identifier (e.g., account number) that signifies the owner of the DR Resource to the Utility.	Customer Identifier		participantID	
The following attributes are used for a DR Resource to enroll in a DR Program.					
DR Program Identifier	This identifies the DR program in which a DR Resource is participating.	DR Program Identifier	Program ID	program	
DR Resource Qualification	This shows the qualification of a DR resource for certain type(s) of DR programs	DR Resource Qualification			
DR Resource Operational Constraints	These are constraints that define the amount load that can be made available during a DR event and includes the following: • Minimum load • Maximum load.	DR Resource Operational Constraints			

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[7] Abbreviation for *OPEN AUTOMATED DEMAND RESPONSE COMMUNICATIONS SPECIFICATION*

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A DR Resource is used during the enrollment process. A DR Resource as a logical entity is a group of Assets that represents a dispatchable entity.

Data Element	Description	Map To			Map to SEP 2.0 TRD
		PAP09 Retail	PAP09 Wholesale	OADRCS[7]	
DR Resource Schedule Constraints	These are a set of constraints that specify when the DR Resource will be available. It may contain such information as: • Time of day schedule constraints • Black out dates • Maximum consecutive days of participation • Maximum duration of DR event participation • Minimum duration of DR event participation • Max number of times per day the DR Resource may be called • Minimum advanced notification necessary Provide details if DR asset or DR resource is in any other DR programs (wholesale and retail)	DR Resource Schedule Constraints		programConstraint	
Effective-Start-Date-Time	The start date and time which an asset/resource is available.	Effective-Start-Date-Time	Effective Enrollment Date		
Program Enrollment Status	Status of the Program Enrollment for the Facility or Resource		Program Enrollment Status		

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A DR Resource is used during the enrollment process. A DR Resource as a logical entity is a group of Assets that represents a dispatchable entity.

Data Element	Description	Map To			Map to SEP 2.0 TRD
		PAP09 Retail	PAP09 Wholesale	OADRCS[7]	
Location	An identifier to indicate the location of the asset/resource.	Location	PAP09 Wholesale (Mandatory) Address1 Address2 City Facility State/Province Facility Zip/Postal Code Facility Country GPS Coordinates Weather Station Zone ID Zone (from CIM) Electrical Node ID Electrical Node Name Electrical Node Type PNode PNode ID	locationInformation	
Location-type	A value used to interpret the value contained in the Location element. Examples of Location-type include: Address Zone GPS Coordinates Grid Location / USNG Electrical Node Zip-code	Location-type			

A DR Resource is used during the enrollment process. A DR Resource as a logical entity is a group of Assets that represents a dispatchable entity.

Data Element	Description	Map To			Map to SEP 2.0 TRD
		PAP09 Retail	PAP09 Wholesale	OADRCS[7]	
Maximum-Duration	The maximum amount of time the asset/resource is capable of delivering power (megawatts), this may be expressed in hours using decimal notation. For example, a value of 0.5 indicates a maximum duration of 30 minutes which the asset/resource can reduce power consumption by the level indicated in Available Capacity.	Maximum-Duration		programConstraint. maxEventDuration	
Minimum-Duration	The minimum amount of time that an Asset/Resource Owner is willing to allow the resource/asset to be utilized during a DR event. It may be expressed in decimal format representing hours. For example, a value of 1.5 indicates that an asset/resource must be utilized for no less than one hour and 30 minutes during any DR event.	Minimum-Duration			
Parent-Resource ID	This is used by an Asset to indicate that it "belongs to" a particular Resource. Assets may be aggregated into a Resource, but are not required to be so aggregated. Resources are autonomous and may not be aggregated.	Parent-Resource ID			

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A DR Resource is used during the enrollment process. A DR Resource as a logical entity is a group of Assets that represents a dispatchable entity.

Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS[7]	Map to SEP 2.0 TRD
Report-type	This indicates the type of report being issued by the Asset or Resource Owner. This is an enumerated value containing one of the following: • REGISTRATION (to register a new asset/resource) • CHANGE (refers to permanent changes) • RETIREMENT.	Report-type			
Response-time	The amount of time before an asset/resource is capable of meeting its full performance, in response to a request by a Service Provider to shed load, expressed as minutes in decimal format.	Response-time			
Hourly-Capacity-Availability	The amount of capacity available for interruption by hour for the period defined by the effective start/end date, expressed in kW or MW with appropriate precision.	Hourly-Capacity-Availability			
Monthly-Capacity-Availability	The average capacity available for interruption by month for the period defined by the effective start/end date, expressed in Megawatts with appropriate precision.	Monthly-Capacity-Availability			
Temporary Opt-Out	This is used to temporarily opt out of DR Events and to override the normal operational constraints. The opt-out can be specified using the following criteria: • All events in a program indefinitely • Specific DR Event • All events in a specific time period. • Other triggered programs for which an asset or DR resource is already called upon (reduce double counting of available capacity)	Temporary Opt-Out			
Removal Effective Date/time	Date/time when the DR resource is no longer available. Date of Termination of Enrollment	Removal Effective Date/time	Enrollment End Date		
Resource / DR Program Attributes from PAP09 Wholesale *Currently out of scope*					
Lead Time	Time between the advanced notification and deployment		Lead Time		

UCAIug OpenSG OpenADR Task Force OpenSG OpenADR 1.0 System Requirements Specification

A DR Resource is used during the enrollment process. A DR Resource as a logical entity is a group of Assets that represents a dispatchable entity.

Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS[7]	Map to SEP 2.0 TRD
Day Ahead Flag	Flag set if the Resource will be participating in the Day-Ahead market		Day Ahead Flag		
Real Time Flag	Flag set if the Resource will be participating in the Real-Time market		Real Time Flag		
Self-Schedule Flag	Flag set if the Resource is Self-Deploying		Self-Schedule Flag		
Response Method Type	Type of Response Method		Response Method Type		
Response Method ID	Identifier assigned to the Response Method		Response Method ID		
Response Method Name	Name of the Response Method		Response Method Name		
Response Method Value	Value of the Response Method		Response Method Value		
Verified Capability	Audited Capability		Verified Capability		
Verified Capability Factor	Ratio of the Verified Capability to the qualified capability		Verified Capability Factor		
Performance Evaluation Method Type Code	Code representing the Type of Measurement		Performance Evaluation Method Type Code		
Performance Evaluation Method	Method used to Evaluate the Performance of a Resource		Performance Evaluation Method		
Mandatory General Asset/Resource Attributes from PAP09 Wholesale			Mandatory General Asset/Resource Attributes from PAP09 Wholesale		
Loss Factor Type	Type of Loss Factor		Loss Factor Type		
Loss Factor (value)	Loss Factor		Loss Factor (value)		

496

3.4.6 DR Asset – Data Requirements

The DR Asset object is used during the enrollment process. A DR Asset as a logical entity has a reportable interval level of consumption. Examples include a site that has its own meter, a neighborhood of homes that has a net meter, or an estimate of consumption of an aggregation of retail customers. Also referred to as Response Method Aggregation (RMA) in PAP09 Wholesale and PAP09 Retail definitions.

Data Element	Description	Map To			
		PAP09 Retail	**PAP09 Wholesale**	**OADRCS[8]**	**Map to SEP 2.0 TRD**
DR Asset Identifier	The unique identifier and name of the DR Assets.	DR Asset Identifier	Response Method Aggregation ID		
DR Asset group ID	Grouping of Assets that can respond to the same DR Signal within a DR Resource. (See DR Resource Specification)	DR Asset group ID			
Asset Operator	The business entity that operates the DR assets	Asset Operator			
Asset Owner	The business entity that owns the DR assets	Asset Owner			
Location-type	A value used to interpret the value contained in the Location element. Examples of Location-type include: Address Zone GPS Coordinates Grid Location / USNG Electrical Node Zip-code	Location-type			
Asset Physical Location	The location of where the DR assets reside	Asset Physical Location		locationInformation	
Authorized Asset Servicers	The authorized service providers of the operation and maintenance of DR assets	Authorized Asset Servicers			
Date of Registration and Last Update	Date of which the DR Assets registered for DR purpose.	Date of Registration and Last Update			
State of Registration Process	The state/status of the registration process of the DR assets.	State of Registration Process			
DR Asset Administrator	• System and Operator • Distribution Utility • Load Serving Entity • Service Providers	DR Asset Administrator			

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[8] Abbreviation for *OPEN AUTOMATED DEMAND RESPONSE COMMUNICATIONS SPECIFICATION*

UCAIug OpenSG OpenADR Task Force OpenSG OpenADR 1.0 System Requirements Specification

The DR Asset object is used during the enrollment process. A DR Asset as a logical entity has a reportable interval level of consumption. Examples include a site that has its own meter, a neighborhood of homes that has a net meter, or an estimate of consumption of an aggregation of retail customers. Also referred to as Response Method Aggregation (RMA) in PAP09 Wholesale and PAP09 Retail definitions.

Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS[8]	Map to SEP 2.0 TRD
DR Asset Availability and Status	Run Status, Set point, Override status, etc.	DR Asset Availability and Status			
DR Asset Physical Capabilities	Ramp Up/Down Rate, Maximum Capacity	DR Asset Physical Capabilities			
DR Asset Product	Manufacturer, Model, Version, Date of Manufacturer	DR Asset Product			
DR Asset Type	(DG, renewable, storage, curtailable or interruptible load)	DR Asset Type			
DR Resources	The identifier of DR resources that the DR Assets belong to.	DR Resources			
Authorized Asset Servicers	The authorized service providers of the operation and maintenance of DR assets	Authorized Asset Servicers			
Contractual Agreements	Contractual agreement under which the DR assets could be removed.	Contractual Agreements			
Third Party Participation	The identification of third parties involved in the removal of DR assets.	Third Party Participation			

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3.4.7 Demand Response Customer Enrollment – Data Requirements

Demand Response customer enrollment is used to register a customer for a DR Program.

Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS[9]	Map to SEP 2.0 TRD
Demand Response Program Identifier	Identifier assigned to the Program	DR Program Identifier	Program ID	UtilityProgram.name	
Customer Identifier	This is a customer identifier (e.g., account number) that signifies the owner of the DR Resource to the Utility.	Customer Identifier		participantID	

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[9] Abbreviation for *OPEN AUTOMATED DEMAND RESPONSE COMMUNICATIONS SPECIFICATION*

3.5 OpenADR Technical Architecture View

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503 Given a large variety of integration technologies that exist in the market place and in the utility enterprises, it
504 would be up to each utility to implement the OpenADR systems requirements specification that fit with their
505 chosen technology infrastructure and architecture goals. However, regardless of the technologies, the following
506 architectural issues are important and needs to be addressed when it comes to achieving interoperability.

3.5.1 Networking Standards

507

508   1. OpenADR services SHALL be provided via TCP/IP (internet) networks. (See [RFC-1122])

509   2. OpenADR services SHALL be exposed primarily using the HTTPS protocol. (See [RFC-1123])

510   3. OpenADR services MAY support Secure FTP. Since OpenADR requires HTTPS, FTP is only an option if both
511   parties implement and agree to use FTP. *(Note that requiring support is in discussion.)*

3.5.2 Security Standards

512

513 A major component of OpenADR is ensuring that protected resources, including data, can and will be secured to prevent
514 unauthorized access. This responsibility originates with the utility, where the data is obtained, and is passed to 3rd Party
515 providers when customers authorize their use of specific utility data. To ensure that data is not provided to unauthorized
516 parties, the constraints and controls documented in [ASAP-SG-3P] are to be complied with for OpenADR installations.

517 Using the terminology specified in the ASAP-SG Third Party Data Access document, the customer is the Resource Owner,
518 the Data Service Provider is the Resource Custodian. (The 3rd Party is still called the Third Party)

3.5.3 Service / Resource Patterns

519

520 Service and/or resource naming standards are important to achieve a level of "plug & play" at the run time
521 environment. It implies the semantics of the service and its operations.

522 The OpenADR services naming convention has the following rules:

523   o **Information Object** – Collection of entities (classes and attributes) to describe an object in a business
524   context.

525   o **Service / Resource Name** – Service naming convention follows the information object in a business
526   process for an interface definition.

527   o **Operation Name** – Operation name indicates a specific action that will be performed to the Information
528   Object. Here is a list of operation naming patterns utilizing IEC 61989 verbs (See IEC61968-1
529   Specification for details):

530   • The following verbs are used for service/operation provided by the master system that owns the
531   Information Object to entertain the request for the specified action implied by the verb.
532   ▪ **Create**
533   ▪ **Change**
534   ▪ **Cancel**
535   ▪ **Close**
536   ▪ **Delete**

537   • The following verbs are used for service/operation provided by systems that are interested in
538   receiving the Information Object as the result of the specified action implied by the verb. This
539   can be invoked by the master system or an intermediary to supply the Information Object.
540   ▪ **Created**
541   ▪ **Changed**
542   ▪ **Closed**
543   ▪ **Canceled**
544   ▪ **Deleted**
545   • The following verbs are used for query type services provided by the master system of the
546   Information Object.
547   ▪ **Get**
548   ▪ **Show**
549   • The following verbs are not used within OpenADR.
550   ▪ **Subscribe**
551   ▪ **Unsubscribe**
552

3.6   Governance

Governance defines the rules by which parties participating in interoperability (integration, or data exchange) efforts can change the interfaces and components providing and consuming them, in order to maintain efficient operation. For OpenADR, governance includes guidelines recommended for addition or extension of standard interfaces, as well as modifications to or extensions to become part of the standard.

1. Changes shall be made to be backwards compatible (optional additions only), to allow existing implementations to continue to operate.

2. Participants are encouraged to submit extensions to the working group as business requirements, with additional recommendations as necessary, to be discussed, ratified, and added to periodic updates.

562 # 4 Appendices

563 ## 4.1 Terms and Definitions

564 This subsection provides the definitions of all terms required to properly interpret the OpenSG OpenADR SRS.

Term	Definition
Advanced Metering Infrastructure (AMI)	The infrastructure built around advanced metering allowing the utility and consumer to communicate in real time with respect to energy consumption. Based on the information collected, the utility is able to obtain an accurate reading of demands, while consumers are able to modify their usage to save energy.
Demand Response	Demand Response is defined as the temporary modification of customer energy usage for a defined duration which is triggered by some condition on the grid such as reliability or market conditions.
Demand Response Program	A Demand Response Program is a program that is created to provide incentive to customers to reduce or shift demand.
IEC	The International Electrotechnical Commission (IEC). The IEC TC57 maintains an electric utility focused information model called CIM (Common information model).
IEC 61968	International standards for Energy Distribution Managements Systems, respectively, specify a Common Information Model (CIM) for utility data exchange, Applications Programming Interfaces (API) for application integration (GID), and XML messaging standards.
Logical Data Model	A representation of an organization's data based upon entities and attributes of those entities. A logical data model is often logical representation of a business' integration or business requirements.
SLA	Service Level Agreement: the part of a service contract where the level of the services are agreed upon between two systems.

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568 4.2 Integration Services – Detailed Messages by Use Case

569 The list of Integration Services defined in section 3.2.2.2 was derived from the sequence interaction defined in the supporting
570 Use Cases. This subsection is a detailed list of each interaction / message in the context of the supporting Use Case.

571 The source of the requirement is defined in the "Requirements Source" column. Since the Service names are based the
572 PAP09 Retail and OpenADR Use Case documents, only the remaining requirements sources are cited individually.

573 Each service is assigned a priority within the current release or defined for a future release as defined in the
574 "Priority/Release" column.

575

Use Case Scenario	Service Name	Provider	Functional Description of the Service	Priority/ Release	Requirements Source
Create DR Program	Created DR Program	DR Controlling Entity	DR Program is created and published.		OADRCS[10] 7.1.3 Program Services
Update DR Program	Updated DR Program	DR Controlling Entity	DR Program is updated and updates published.		OADRCS 7.1.3
Cancel DR Program	Cancelled DR Program	DR Controlling Entity	DR Program is terminated and notice published.		OADRCS 7.1.3
Register Customer for DR Program	Register Customer for a DR Program	DR Controlling Entity	Register a Customer for a DR Program. Customer registers with DR Controlling Entity (Utility or DRP).		OADRCS 7.1.3
Update Customer for DR Program	Update Customer for a DR Program	DR Controlling Entity	Updates to Customer registration information are provided for Utility or DRP.		OADRCS 7.1.3
Remove Customer from DR Program	Cancel Customer for DR Program	DR Controlling Entity	Customer notifies Utility or DRP of cancellation/removal from DR program. (Contingent on contractual obligations)		OADRCS 7.1.3
Register DR Resource	Register DR Resource	DR Controlling Entity	The Resource is registered and associated with a Customer and DR Program		
Remove DR Resource	Remove DR Resource	DR Controlling Entity	The Resource is removed from DR Program.		
Register DR Asset	Register DR Asset	DR Controlling Entity	The Asset is registered and associated with a Customer and DR Program		
Update DR Asset	Update DR Asset	DR Controlling Entity	The Asset is updated.		
Remove DR Asset	Remove DR Asset	DR Controlling Entity	The Asset is removed from DR Program		
DR Bidding			Process currently out of scope	Phase II	OADRCS 7.1.2
DR Event Advance Notification	Notify DR Event	DR Controlling Entity	DR Controlling Entity provides the advance notification of a DR Event to a DR Resource to provide scheduled Operation Mode and Event		OADRCS 7.1.1

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[10] Abbreviation for *OPEN AUTOMATED DEMAND RESPONSE COMMUNICATIONS SPECIFICATION*

Use Case Scenario	Service Name	Provider	Functional Description of the Service	Priority/ Release	Requirements Source
			Information		
DR Event Advance Notification	Confirm DR Resource for Event	DR Resource	DR Resource opts in/out for DR Event. Response to DR Event Advance Notification and Update DR Event.		OADRCS 7.1.1
Update DR Event	Update DR Event	DR Controlling Entity	Update of Event Notice for Resource.		OADRCS 7.1.1
Cancel DR Event	Cancel DR Event	DR Controlling Entity	Cancellation notice from DR Controlling Entity to DR Resource.		OADRCS 7.1.1
DR Broadcast Message (Price Plus)	Broadcast DR Message	DR Controlling Entity	DR Broadcast Message to DR Resource for Pricing Information. (May include other attributes of Energy Delivery)		
Dispatch DR Instructions (Retail)	Dispatch DR Instruction	DR Controlling Entity	DR Controlling Entity provides specific objectives to the DR Resource.		
Dispatch DR Instructions (Retail)	Confirm DR Resource	DR Resource	DR Resource Confirms DR Instruction (with opt in/out) Non-repudiation required.		OADRCS 7.3.1
DR Direct Load Control (Retail)	Created Direct Load Control	DR Controlling Entity	Direct interactions between the DR Service Provider and a specific DR Asset for the purposes of putting that asset into a specific load control state (e.g., to turn it on or off). In this case, the DR Asset is a DR Resource with only one DR Asset, and thus, the interaction is directly with the DR Asset.		SEP2TRD[11] 10.4
Monitor DR Event (DR Resource)	Monitor DR Event (DR Resource)	DR Resource	Response from DR Resource to DR Controlling Entity used to monitor a DR Resource's behavior. It may be executed as a result of the DR Resource receiving a DR signal or it may be conducted continuously.		SEP2TRD 10.4
Monitor DR Event (DR Asset)	Publish DR Asset Status	DR Asset	Response from DR Asset to DR Controlling Entity used to monitor a DR Asset's behavior. It may be executed as a result of the DR Asset receiving a DR signal or it may be conducted continuously.		SEP2TRD 10.4
DR Execution – Real Time Pricing (RTP) / Dynamic Price Based	Forecast Load By Circuit	DR Controlling Entity	DR Controlling Entity provides Load Forecast to UDC and MO. [Content undefined]	Low compared to execution phase	
DR Execution – Real Time Pricing (RTP) / Dynamic Price Based	Broadcast Locational Wholesale Price	SO or MO	Wholesale Locational Price Information provided by the SO or MO to the LSE	Work with wholesale guys, touchpoint	
DR Execution – Real Time	Broadcast Locational Retail Price	LSE	Retail Locational Price Information provided by the LSE to the Customer and DR Controlling Entity after aggregation and uplift.	touchpoint	EIS[12]-UC-19,ID3

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[11] Abbreviation for ZigBee Smart Energy Profile™ 2.0 Technical Requirements Document

Use Case Scenario	Service Name	Provider	Functional Description of the Service	Priority/ Release	Requirements Source
Pricing (RTP) / Dynamic Price Based					
DR Execution – Real Time Pricing (RTP) / Dynamic Price Based	Update Load Forecast (Forecast DR)	DR Controlling Entity	DR Controlling Entity provides Load Forecast adjusted by expected DR to LSE.	Open issue on how modeled (PAP03) gap	EIS-ID15 (Customer to DRCE)
DR Execution – Real Time Pricing (RTP) / Dynamic Price Based	Update Load Forecast by Circuit (Forecast DR by Circuit)	DR Controlling Entity	DR Controlling Entity provides Load Forecast by Circuit adjusted by expected DR to UDC.		
DR Execution – Real Time Pricing (RTP) / Dynamic Price Based	Schedule Approved, No violations	UDC	UDC approves DR Schedule based on check against circuit limits		
DR Execution – Real Time Pricing (RTP) / Dynamic Price Based	Suggested Schedule Adjustment	UDC	UDC sends suggested schedule adjustments based on circuit limits. (Process for reprocessing schedule is not defined)		
DR Execution – Notification Based	Load Forecast	DR Controlling Entity	DR Controlling Entity provide Load Forecast to SO/MO		
DR Execution – Notification Based	Load Forecast by Circuit	DR Controlling Entity	DR Controlling Entity provides Load Forecast by Circuit to UDC		
DR Execution – Notification Based	DR Capability	Customer	Customer notifies DRP of DR Capability (Same as Status/State)		
DR Execution – Notification Based	DR Nomination	DR Controlling Entity	DR Controlling Entity Nominates DR Capability to LSE and SO/MO From PAP09 Retail – "The DR capabilities are specified by the DR Provider to the System Operator based on a DR Program, a price curve, or other nomination protocol." Message attributes include Dispatch instructions.		
DR Execution – Notification Based	DR Dispatch Instructions	SO/MO	SO/MO sends DR Dispatch Instructions to DRP and LSE		

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[12] Abbreviation for *Energy Information Standards (EIS) Alliance Customer Domain Use Cases*

Use Case Scenario	Service Name	Provider	Functional Description of the Service	Priority/ Release	Requirements Source
DR Execution – Notification Based	DR Schedule by Circuit	DR Controlling Entity	DR Controlling Entity provides DR Schedule by Circuit to UDC.		
DR Execution – Notification Based	Schedule Approved, No violations	UDC	UDC approves DR Schedule based on check against circuit limits		
DR Execution – Notification Based	Suggested Schedule Adjustment	UDC	UDC sends suggested schedule adjustments based on circuit limits. (Process for reprocessing schedule is not defined)		
DR Execution – Notification Based	Final DR Schedule	DR Controlling Entity	DR Controlling Entity sends final DR Schedule to LSE based on Approved Schedules.		
DR Execution – Notification Based	Notify Customer of DR Schedule	DR Controlling Entity	DR Controlling Entity Notifies Customer of DR Schedule		
DR Execution – Direct Load Control (DLC)	DR Capability	Customer	Customer notified DRP of DR capability.		
DR Execution – Direct Load Control (DLC)	DR Capability Aggregated by Network Location	DR Controlling Entity	DR Controlling Entity provides DR Capability aggregated by network location to UDC.		
DR Execution – Direct Load Control (DLC)	DR Capability Aggregated by Location	DR Controlling Entity	DR Controlling Entity provides DR Capability aggregated by network location to SO/MO.		
DR Execution – Direct Load Control (DLC)	DR Dispatch Instructions	SO/MO	SO/MO sends DR Dispatch Instructions to DRP and LSE		
DR Execution – Direct Load Control (DLC)	Advisory Information on pending DR	DR Controlling Entity	DR Controlling Entity send advisory to LSE of pending DR Event		
DR Execution – Direct Load Control (DLC)	DR Control Schedule by Circuit	DR Controlling Entity	DR Controlling Entity provides DR Schedule by Circuit to UDC.		
DR Execution – Direct Load Control (DLC)	Schedule Approved, No violations	UDC	UDC approves DR Schedule based on check against circuit limits and notifies DRP.		
DR Execution – Direct Load Control	Suggested Schedule Adjustment	UDC	UDC sends suggested schedule adjustments based on circuit limits to DRP. (Process for reprocessing schedule is not defined)		

Use Case Scenario	Service Name	Provider	Functional Description of the Service	Priority/ Release	Requirements Source
(DLC)					
DR Execution – Direct Load Control (DLC)	Control Signal	DR Controlling Entity	DR Controlling Entity send control signal to Customer asset.		
DR Execution – Direct Load Control (DLC)	Telemetry Data	Customer Asset	Customer Asset provides telemetry data to DR Controlling Entity.		
DR Execution – Direct Load Control (DLC)	Aggregated DR Telemetry	DR Controlling Entity	DR Controlling Entity provides aggregated telemetry data to SO/MO		
Post DR Event M&V / Settlement (Open Retail)	Request Meter Read	LSE	LSE requests meter read from Customer Resource		
Post DR Event M&V / Settlement (Open Retail)	Created Meter Read	Resource	Resource provides meter read to LSE		
Post DR Event M&V / Settlement (Open Retail)	Created Meter Read	LSE	LSE provides meter read to DR Controlling Entity		
Post DR Event M&V / Settlement (Open Retail)	Created Billing	DR Controlling Entity or LSE	DR Controlling Entity or LSE provides Billing information to Customer.		
Post DR Event M&V / Settlement (No Open Retail)	Request Meter Read	LSE	LSE requests meter read from Customer Resource		
Post DR Event M&V / Settlement (No Open Retail)	Created Meter Read	Resource	Resource provides meter read to LSE (Read interval must match interval of DR Event)		
Post DR Event M&V / Settlement (No Open Retail)	Created Billing	LSE	LSE provides Billing information to Customer.		

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