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## OpenADR 1.0 System Requirements Specification

2

*Version: Approved v1.0*

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4

**Release Date: 9/29/2010**

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7 work of the OpenADR System Requirements Specification:

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22 companies for their support of this important endeavor as it sets a key foundation for an  
23 interoperable Smart Grid.

24 **Document History**

25 **Revision History**

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27

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28 **Open Items and Issues Log**

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30

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

32

Item No.	Date	Provided By	Summary of the Issue	Status / Disposition

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80 **1 Introduction**

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

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

- 90     ▪ Common business processes and functional requirements
- 91     ▪ Common architecture principles and patterns
- 92     ▪ Common information requirements and model
- 93     ▪ Common integration services (functional & informational)

---

94 **1.1 Purpose**

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

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<sup>1</sup> 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*.

<sup>2</sup> *Requirements Specifications for Wholesale Standard DR Signals - for NIST PAP09, Requirements Specifications for Retail Standard DR Signals - for NIST PAP09*

101 **1.2 Scope**

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

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

120 The SRS defines the logical components and business functions in order to identify the interfaces that  
121 must be specified to enable interoperability across different implementations, for many utilities to many  
122 3rd Parties. It includes architectural aspects and specific requirements. The inputs include OpenADR  
123 use cases, as well as industry best practices and standards, including information models and other  
124 specifications.

125 **1.2.1 Scope of This Release**

126 OpenADR SRS 1.0 addresses the following functional areas:

- 127 • Direct Load Control Signals
- 128 • Dispatching of Load Profiles
- 129 • DR Related Pricing Signals
- 130 • DER applications (Limited to the context of grid-connected DR and to those DER devices that can  
131 affect load levels on the grid. Excludes injection of power and micro-grids)
- 132 • DR Program Management (Limited to data required to support DR Signals)
  - 133 ○ Program and Customer Registration
  - 134 ○ DR Resource Registration

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135 1.2.2 Scope of Subsequent Releases

- 136 • Utility internal systems integration for DR purposes
- 137 • DR Bidding
- 138       ○ DR Offer to Supply (Retail Offers)
- 139       ○ DR Bid to Buy
- 140 • Forecasting
- 141 • Some types of Ancillary Services:
- 142       ○ Low latency or control system type interactions that are characteristic of some Ancillary
- 143       Services (i.e. Frequency Regulation) are fundamentally different type of interaction that
- 144       requires further consideration and modeling.
- 145
- 146

147 The OpenADR SRS does not include the following items that are typically a part of solution

148 architecture. Some of them are or have been addressed by other parts of the OpenSG initiative. Others

149 will need to be dealt with specifically for each implementation.

- 150       ▪ Network and hardware infrastructure architecture
- 151       ▪ Operational architecture
- 152       ▪ Testing methodology and architecture
- 153       ▪ Internal application architecture

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154 **1.3 Acronyms and Abbreviations**

155 This subsection provides a list of all acronyms and abbreviations required to properly interpret the

156 OpenSG OpenADR System Requirements Specification.

Acronym	Name
ADE	Automatic Data Exchange
ADR	Automated Demand Response
AMI	Advanced Metering Infrastructure
AS	Ancillary Services
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

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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

157  
158

---

159 **1.4 External Considerations and References**

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

161

- 162 • Open ADR Functional Requirements and Use Case Document (OpenSG)
- 163 • Requirements Specifications for Wholesale Standard DR Signals - for NIST PAP09
- 164 • Requirements Specifications for Retail Standard DR Signals - for NIST PAP09
- 165 • OPEN AUTOMATED DEMAND RESPONSE COMMUNICATIONS SPECIFICATION - Public
- 166 Interest Energy Research (PIER), California Energy Commission
- 167 • Requirements Specifications for Common Electricity Product and Pricing Definition - for NIST
- 168 PAP03
- 169 • Requirements Specifications for Common Scheduling Mechanism for Energy Transactions - for
- 170 NIST PAP04
- 171 • ZigBee Smart Energy Profile™ 2.0 Technical Requirements Document
- 172 • Smart Energy Profile Specification ZigBee Profile: 0x0109 Revision 15
- 173 • Energy Information Standards (EIS) Alliance Customer Domain Use Cases
- 174 • Energy Information Standards (EIS) Alliance Customer Domain Energy Services Interface (ESI)
- 175 Requirements
- 176 • Energy Interoperation Version 1.0 - © OASIS® 2010
- 177 • Smart Grid Communication Standards for Demand Response Data Requirements – (IRC) ISO/RTO
- 178 Council for PAP09
- 179 • Transactional Energy Market Information Exchange (TeMIX) An Information Model for Energy
- 180 Transactions in the Smart Grid - By Edward G. Cazalet, PhD on behalf of the OASIS Energy Market
- 181 Information Exchange Technical Committee

182

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

185

- 186 • IETF Internet Suite - Internet Standards, including the following
- 187 • [RFC-793] IETF Transmission Control Protocol (TCP)

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- 188 • [RFC-791] IETF Internet Protocol (IP)
- 189 • [RFC-2616] Hypertext Transfer Protocol -- HTTP/1.1
- 190 • [IEC-61968] IEC TC57 Working Group 14 (IEC 61968) (Common Information Model)
- 191 • [ASAP-SG-3P] Security Profile for Third Party Access (ASAP-SG)
- 192 • W3C XML, XML Schema related standards
- 193 • OASIS Web Services related standards

194 1.4.1 RFC 2119 Keyword interpretation

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

---

198 **1.5 Document Overview**

199 TOGAF 9.0 defines four architecture domains that are commonly accepted as subsets of overall  
200 enterprise architecture, all of which TOGAF is designed to support, see [Figure 1](#).

- 201 • **Architecture Vision** defines overall architecture guiding principles, goals and objectives and desired  
202 traits.
- 203 • The **Business Architecture** defines the business strategy, governance, organization, and key  
204 business processes.
- 205 • The **Information Systems Architecture**, including the following.
  - 206 ○ The **Data Architecture** describes the structure of an organization's logical and physical data  
207 assets and data management resources.
  - 208 ○ The **Application Architecture** provides a blueprint for the individual application systems to be  
209 deployed, their interactions, and their relationships to the core business processes of the  
210 organization.
- 211 • The **Technology Architecture** describes the logical software and hardware capabilities that are  
212 required to support the deployment of business, data, and application services. This includes IT  
213 infrastructure, middleware, networks, communications, processing, standards, etc.

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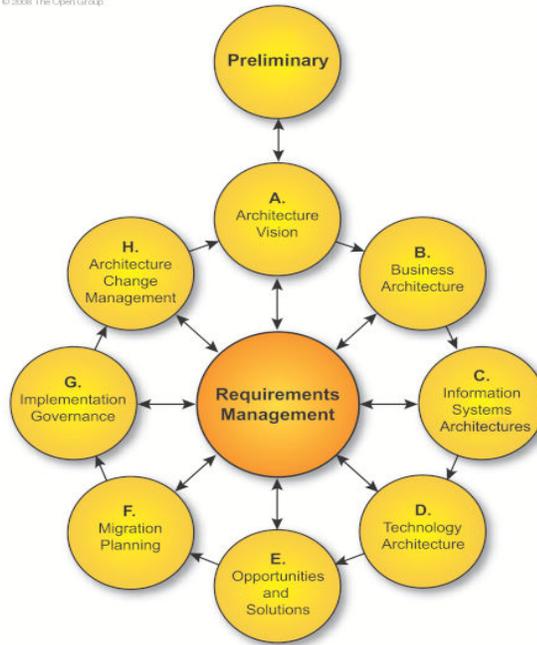


Figure 1. The Open Group Architecture Framework (TOGAF) architecture development cycle.

As such, the document will be structured as follows:

**Section 2** describes the overall Architecture Vision for the system, including Guiding Principles, Architectural Considerations, and the OpenADR Reference Model, all relevant to providing a consistent framework within which the four architecture components can be developed.

**Section 3** provides details on the following:

1. **Business Architecture:** This will refer to work products produced by the Use Case and Service Definition Teams of OpenADR, which includes the list of use cases and integration requirements and business services at the functional level.
2. **Data Architecture:** This provides the technical level requirements relative to how the OpenADR data should be modeled and represented consistently across all integration services to ensure semantic interoperability.
3. **Application Architecture:** This provides the technical level requirements relative to how applications are modeled as logical components, and what services each logical component may provide or consume. This should be an instantiation of the business services identified within the Business Architecture.
4. **Technology Architecture:** This provides the technical level requirements relative to how services will interact with each other to support end-to-end AMI business processes.

**Section 4** contains the Appendices, which includes terms and definitions, logical components list, integration requirements list, and integration services view.

239

## 2 Architecture Vision

240

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

241

242

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

243

244

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246

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

247

248

249

250

Although not shown in the diagram below the architecture does not preclude the use of intermediaries such as aggregators or third party control companies that may receive DR signals on behalf of the end user facilities. This is discussed in more detail in section 2.1 [Architectural Goals and Guiding Principles](#), where the concepts of a Resource Energy Controller and Virtual End Node are introduced.

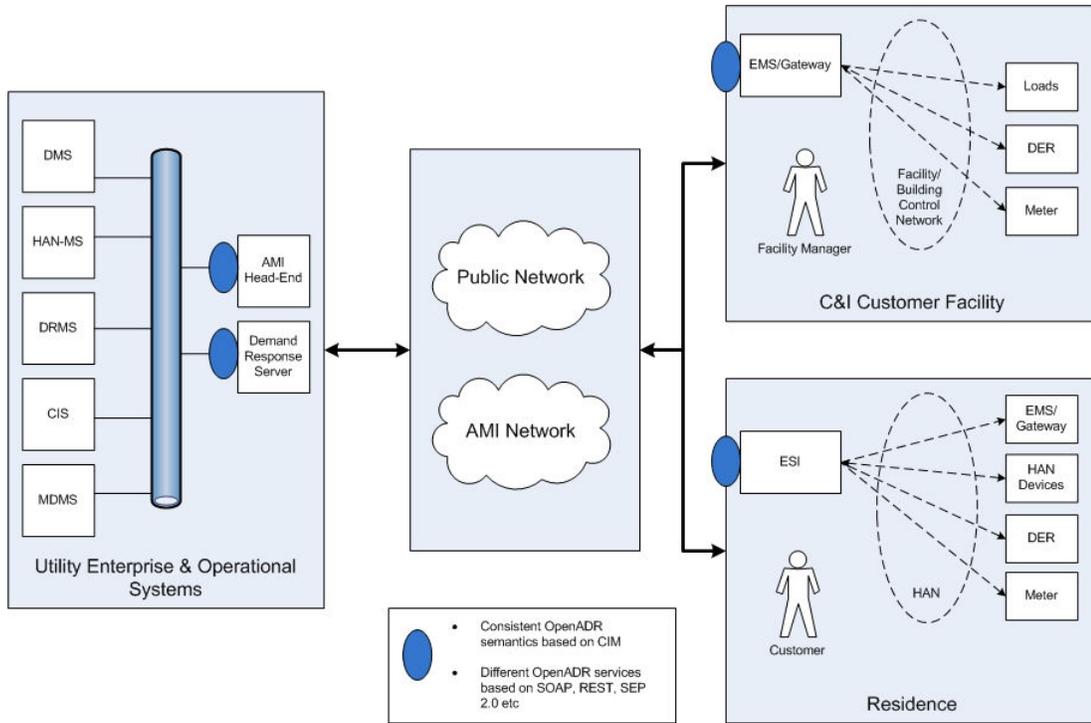
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256

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

257

Following table defines the components identified in Figure 2.

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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 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.

258

259 **2.1 Architectural Goals and Guiding Principles**

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

- 268 • Exchanges of data cross enterprise boundaries
  - 269 ○ Industry best practices must be followed
  - 270 ○ The most interoperable and widely supported technologies should be used to ensure
  - 271 adoption regardless of development and deployment platforms used
  - 272 ○ The technologies chosen shall be well specified, with active communities and tools
  - 273 and/or frameworks available. For example, WS-I, or RESTful in conjunction with
  - 274 AtomPub, OData or GData.
  - 275 ○ Technologies chosen shall be compatible and interoperable with technologies specified
  - 276 for access on premise or HAN resources.
  - 277 ○ Security and privacy of customer information is of utmost importance, since transfers
  - 278 must support the secure use of public networks, and sensitive customer information may
  - 279 be exchanged across enterprise boundaries.
- 280 • Recommendations must promote and enable interoperability
  - 281 ○ Many utilities need to be interoperable with many 3rd Parties, so there are significant
  - 282 efficiency savings possible by defining a common interface for the OpenADR message
  - 283 exchanges. Therefore, recommendations must be specific and prescriptive, actionable and
  - 284 testable
- 285 • Must meet the goals of several different types of stakeholders
  - 286 ○ Requires an open process to allow discussion and negotiation of the recommendation
- 287 • Forwards and backwards version compatibility is needed
  - 288 ○ Existing implementations must remain operational when either side adds future
  - 289 extensions

---

290 **2.2 Architectural Considerations**

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

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- 294
- System quality attributes discernable at runtime
    - 295 ○ Performance - Services SHALL provide and consume data in a timely manner as defined
    - 296 by the requirements.
      - 297 • Clock Accuracy – Services that are actionable based on specified date, time, and
      - 298 duration SHALL ensure that sufficient clock accuracy is maintained to provide
      - 299 timely response.
    - 300 ○ Security –
      - 301 • Parties involved in any DR event SHALL be authenticated and authorized;
      - 302 • Command/message exchanged between parties involved in any DR event SHALL
      - 303 be secure from end to end.
      - 304 • Results of the DR event execution SHALL be auditable.
    - 305 ○ Authorization – Protected resources SHALL be authorized individually by the user(s)
    - 306 associated with those resources.
    - 307 ○ Availability – Services SHALL be highly available as defined by the requirements.
    - 308 ○ Functionality – SHALL meet the functional needs of customers and regulators
    - 309 ○ Usability – SHALL require only commonly available tools and technologies
    - 310 ○ Scalability – SHALL be able to add additional servers to meet performance
  - 311 • System quality attributes requiring assessment for evaluation
    - 312 ○ Modifiability – SHALL allow additions without affecting existing systems
    - 313 ○ Portability – SHALL be possible to implement on a variety of platforms
    - 314 ○ Reusability – SHALL use standard industry object representations
    - 315 ○ Integrability – SHALL be possible to map to a variety of other interfaces
    - 316 ○ Testability – SHALL be possible to perform testing using a variety of methods
  - 317 • Business Qualities
    - 318 ○ Cost – SHALL not be cost-prohibitive
    - 319 ○ Projected life time of the system – SHALL allow growth
  - 320 • Qualities directly related to the architecture
    - 321 ○ Conceptual integrity – Semantics of defined elements SHALL be consistent across
    - 322 objects that use those elements
    - 323 ○ Correctness and completeness - Is aligned with common application architectures and
    - 324 addresses all considerations required for interoperability.

325 Note that desired, minimum and maximum levels for performance, availability, functionality, acceptable  
326 use, clock accuracy and other characteristics will likely be specified and negotiated in Service Level  
327 Agreements (SLAs) between DR Signal consumers and providers.

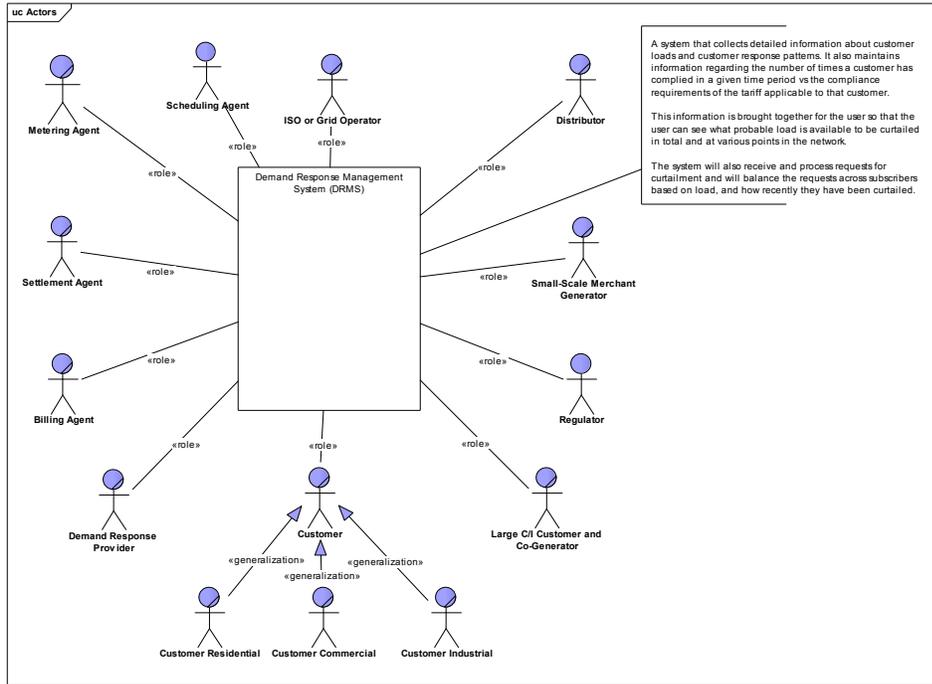
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328 Regulators may also require certain service levels. Each side will likely have some number of terms  
329 required for use of their services. This is not part of the standardization effort, just a note to prepare for  
330 these agreements.

331 **3 OpenADR Systems Architecture**

332 **3.1 OpenADR Business Architecture View**

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



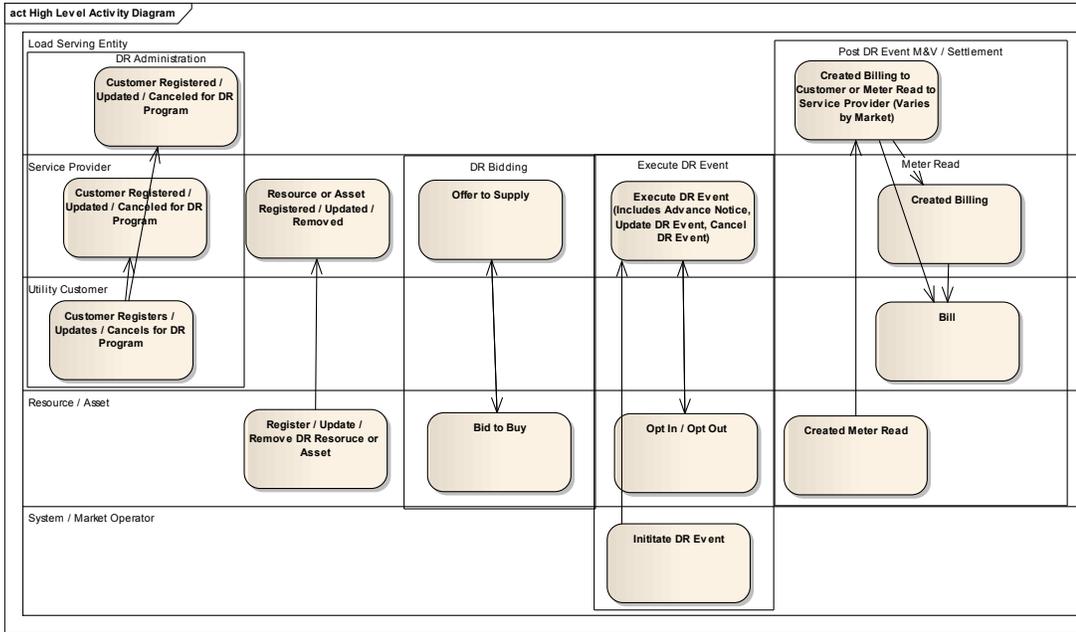
337 **Figure 3. OpenADR Stakeholders Overview**

338  
 339  
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341 The primary business flows include DR Program Administration, Bidding, and Execution as shown in  
 342 the following diagram. The swim lanes represent business roles and the blocks within the swim lanes  
 343 correspond to a business process carried out by that business role. Business roles are related to the  
 344 Actors identified earlier; however, in some cases multiple Actors may carry out the same business role.  
 345 For example, an ISO/RTO, Utility Distribution Company (UDC), Load Serving Entity, or DR  
 346 Aggregator can all perform the business role of Service Provider. The business processes shown are  
 347 those that involve the exchange of information between business roles.

348



349

350 **Figure 4. Overview of Business Process Flows**

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

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

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

<b>Business Role</b>	<b>Description / Key Business Functions</b>	<b>Map to NIST</b>	<b>Map to LBNL</b>
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. (Requirements Specifications for Retail Standard DR Signals - for NIST PAP09 dated 5/13/2010)  The Business Role of Service Provider as used in the PAP09 Retail Use Cases is also referred to as a DR Aggregator. See "Aggregators and Curtailment Service Providers" below.	Service Provider	
DR Asset	An end device that is capable of shedding or managing load in response to Demand Response Events, Energy or AS Price Signals or other system events (e.g. under frequency detection).		
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 or managing load in response to a triggering event. Unlike a DR Asset, which is atomic, 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 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)		DRAS Client
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		

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Business Role	Description / Key Business Functions	Map to NIST	Map to LBNL
	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)		

360

361 **Aggregators and Curtailment Service Providers**

362 The terminology used regarding Aggregators and Service Providers is summarized in “*Framework for*  
363 *Integrated Demand Response (DR) and Distributed Energy Resources (DER) Models*”:

364 In the organized markets (wholesale electricity markets), generally the end use customer does not  
365 participate directly in the market. An intermediary aggregates these end use customers and  
366 presents this aggregated capability to reduce consumption to the organized market. The Federal  
367 Energy Regulatory Commission (FERC) refers to these entities as Aggregators of Retail  
368 Customers (ARC), and these entities are also called Curtailment Service Providers (CSP) or  
369 Demand Response provides (DRP) in the wholesale market place. Local distribution companies  
370 (LDC) may also aggregate retail customers for Demand Response and present these curtailments  
371 to the wholesale market. The ARC, CPS, DRP and LDC are wholesale market participants and  
372 may provide various services to the wholesale market based on the specific market rules.

373 For the purposes of this specification, the term DR Aggregator is synonymous with an ARC or CSP.

374 **3.2 Integration Requirements Specification**

375 3.2.1 Functional Requirements – Business Processes

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

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

- 381     ▪ Administrate Customer for DR (Limited to data required to support DR Signals)
  - 382         ○ Register / Enroll Customer for DR Program
  - 383         ○ Remove Customer from DR Program
- 384     ▪ Administrate DR Resource (Limited to data required to support DR Signals)
  - 385         ○ Administrate Distribution DR Resource
  - 386         ○ Update DR Resource
  - 387         ○ Register DR Resource
- 388     ▪ Administrate DR Asset (Direct Load Control)
  - 389         ○ Register DR Asset
  - 390         ○ Update DR Asset
  - 391         ○ Remove DR Asset
- 392     ▪ DR Bidding
  - 393         ○ DR Bid to Supply (Retail Offers)
  - 394         ○ DR Bid to Buy
- 395     ▪ Execute DR Event
  - 396         ○ Notify DR Event
    - 397             ▪ Advanced Notification for DR
    - 398             ▪ Update a DR Event
    - 399             ▪ Cancel a DR Event
    - 400             ▪ DR Resource Confirmation
  - 401         ○ Dispatch DR Objectives
  - 402         ○ DR Direct Load Control
    - 403             ▪ Monitor DR Event (DR Resource)
    - 404             ▪ Monitor DR Event (DR Asset)

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- 405           ○ DR Real Time Pricing (RTP)
- 406        ■ Operational Coordination
- 407            ■ Post DR Event Management (out of scope, handled by other groups: AMI-ENT
- 408            and M&V Settlement Standards)
- 409            ■ Post DR Event M&V / Settlement (No Open Retail)
- 410            ■ Post DR Event M&V / Settlement (Open Retail)

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411 3.2.2 Functional Requirements – Integration Services

412 3.2.2.1 Logical Components

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

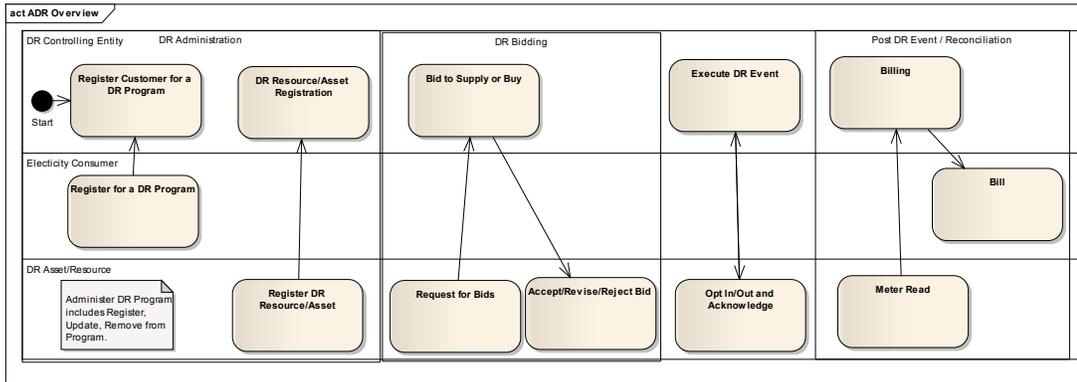
422 Following is a table listing all major logical components that will provide some functions to support  
 423 ADR business processes. All services will be organized accordingly.

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 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 and 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 end device that is capable of shedding or managing load in response to Demand Response Events, Energy or AS Price Signals or other system events (e.g. under frequency detection).		
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 or managing load in response to a triggering event. Unlike a DR Asset, which is atomic, 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 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).		

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Logical Components	Description / Key Business Functions	Map to NIST	Map to LBNL
	(PAP09 Retail dated 2/11/2010 v 1.5)		
System and Market Operator	<p>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).</p> <p>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.</p> <p>(PAP09 Retail dated 2/11/2010 v 1.5)</p>		

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

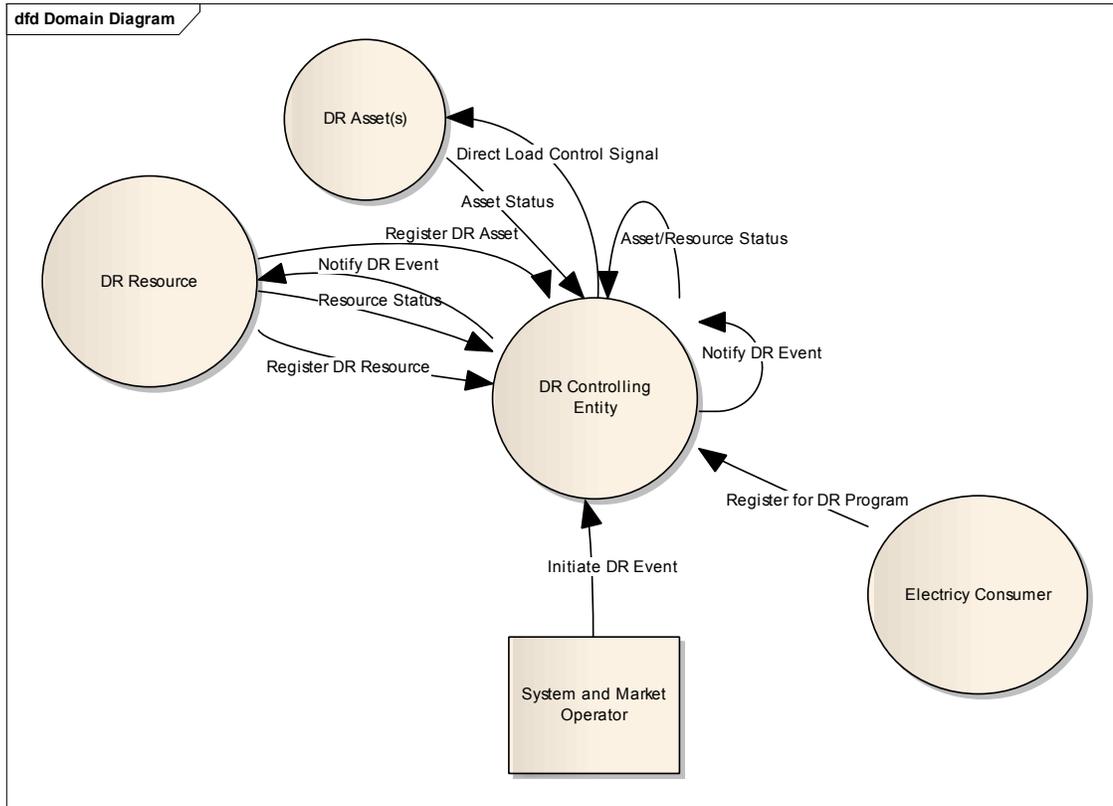


426 **Figure 5. Overview of Business Process Flows Using Logical Components.**

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

429



430

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

431

432

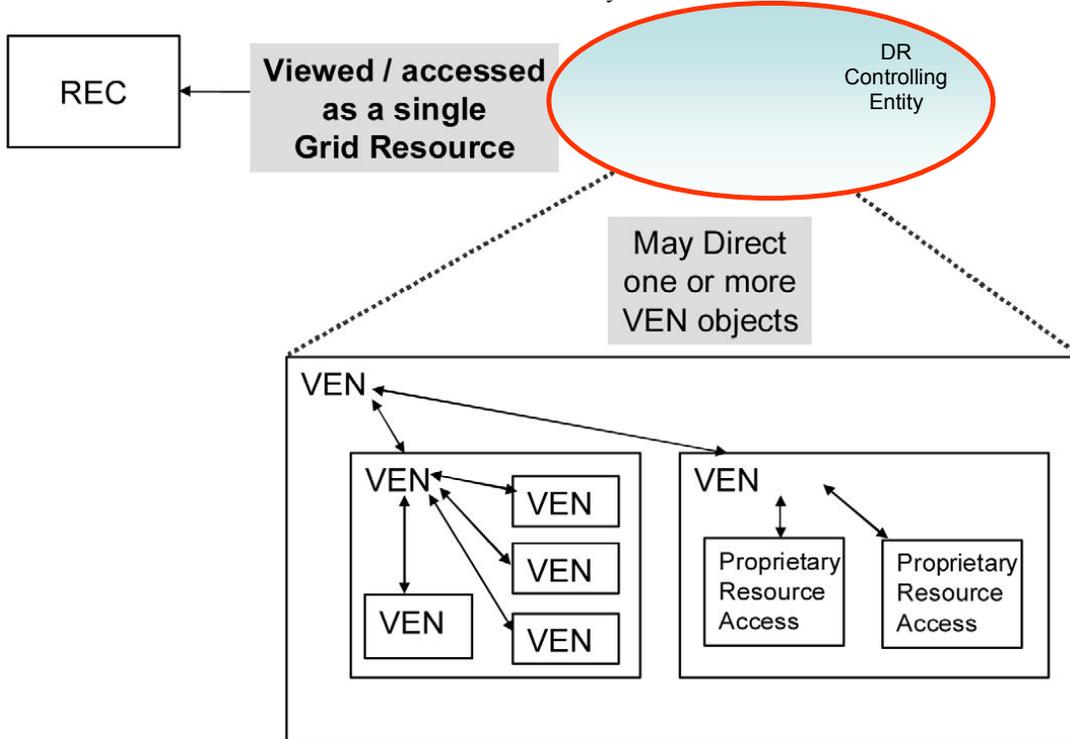
433 Note that a DR Controlling Entity may represent a single Actor, such as a Utility Distribution Company  
434 in the business role of a Load Serving Entity. However, a DR Controlling Entity may also represent a  
435 hierarchy of entities, such as an ISO/RTO dispatching DR instructions to a Transmission Operator, who  
436 in turn sends the dispatch instructions on to a UDC, who sends instructions to a DR Aggregator, who  
437 then directs a specific DR Resource to execute the instruction. This can be modeled as a recursive  
438 relationship with DR Controlling Entity which represents each of these Actors in an integration role. The  
439 goal is to minimize the number of different logical components and hence the number of different  
440 services and message payloads that need to be defined through reuse of the standard services and  
441 payload definitions.

442

443 This concept is elaborated more extensively in a recent EPRI report titled *Concepts to Enable*  
444 *Advancement of Distributed Energy Resources*. This approach is made possible as we shift from

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445 designing *control* systems which issue direct load controls to system viewed as a grid resource which  
 446 “has the ability to handle a situation in an effective manner”<sup>3</sup>, where the “how” of the response is  
 447 replaced by a description of the situation requiring a change in energy consumption, leaving it to the  
 448 final DR Resource to know how to control DR Assets to effect the desired change in energy use. The  
 449 concept put forward by the EPRI report is called the REC-VEN concept, where the REC (Resource  
 450 Energy Controller) determines when and why to send specific grid messages to the resources it manages,  
 451 which are represented as a VEN (Virtual End Node). A VEN can in turn also function as a REC to  
 452 another VEN which is lower down in the control hierarchy.  
 453



454  
 455 **Figure 7. REC-VEN Operations**, adapted from: *Concepts to Enable Advancement of Distributed Energy*  
 456 *Resources: White Paper on DER*. EPRI, Palo Alto, CA : 2010. 1020432

457  
 458 In the diagram above, the DR Controlling Entity can be thought of as a VEN-REC object, thus  
 459 representing all the entities in series from the System and Market Operator to the DR Resource. This is  
 460 modeled by adding a recursive relation to a DR Controlling Entities, so that the DR Controlling Entity in  
 461 the diagram represents one or more entities. This approach ensures a scalable architecture for all future  
 462 Smart Grid developments.

<sup>3</sup> Concepts to Enable Advancement of Distributed Energy Resources: White Paper on DER. EPRI, Palo Alto, CA : 2010. 1020432

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463 3.2.2.2 Integration Services

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

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

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

474

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 <i>Utility AMI AMI-ENT System Requirements Specification</i> , Utility AMI-ENT Task Force. The meter read interval is determined by the interval of DR Event participation.	n/a
DR Bidding				5

475

476

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477 3.2.3 Technical Requirements – Integration Services

478

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

- 482 • Common protocol and business semantics SHALL be used to achieve loose coupling of end-  
483 point service (directly or indirectly)
- 484 • Services SHALL be representative of a unique unit of work and reusable across business  
485 functions.
- 486 • Services SHALL be reusable across common practices of utilities.
- 487 • Service design SHALL be driven by business requirements and reflected in the architecture.
- 488 • Service design SHALL be governed with a common approach and framework to achieve  
489 conceptual integrity.
- 490 • Service level agreement should be defined to support key architecture qualities: security,  
491 reliability, performance, availability, scalability, data quality, information fidelity, etc.

---

492 **3.3 OpenADR Application Architecture View**

- 493 1. Audit information SHOULD be maintained, so that a report could be produced containing details  
494 (who, what, when, etc.) about authorizations, transfers, and other significant events.
- 495 2. OpenADR Application Architecture SHALL provide measures that protect and defend  
496 information and information systems by ensuring their availability, integrity, authentication,  
497 confidentiality, and non-repudiation.

498 **3.4 OpenADR Data Architecture View**

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

- 501 • DR Customer Enrollment
  - 502 ○ Register Customer for DR Program
  - 503 ○ Update Customer for DR Program
  - 504 ○ Remove Customer from DR Program
- 505 • DR Asset (End Device)
  - 506 ○ Register Asset for DR Program
  - 507 ○ Update Asset for DR Program
  - 508 ○ Remove Asset from DR Program
- 509 • DR Resource (Device Group)
  - 510 ○ Register Resource for DR Program
  - 511 ○ Update Resource for DR Program
  - 512 ○ Remove Resource from DR Program
- 513 • Notify Demand Response Event
  - 514 ○ Advance Notification
  - 515 ○ Update Event
  - 516 ○ Cancel Event
- 517 • Demand Response Event
  - 518 ○ Types:
    - 519 ▪ Direct Load Control Signal
    - 520 ▪ Demand Response Instructions / Objectives (DR Dispatch)
    - 521 ▪ Price Signal / Schedule
  - 522 ○ Updates
  - 523 ○ Cancel
- 524 • Forecast Demand (out of scope)
- 525 • Asset / Resource Status (Monitor Demand Response Event)
  - 526 ○ Response to Signal
  - 527 ○ Get Status/State
  - 528 ○ Continuous Response

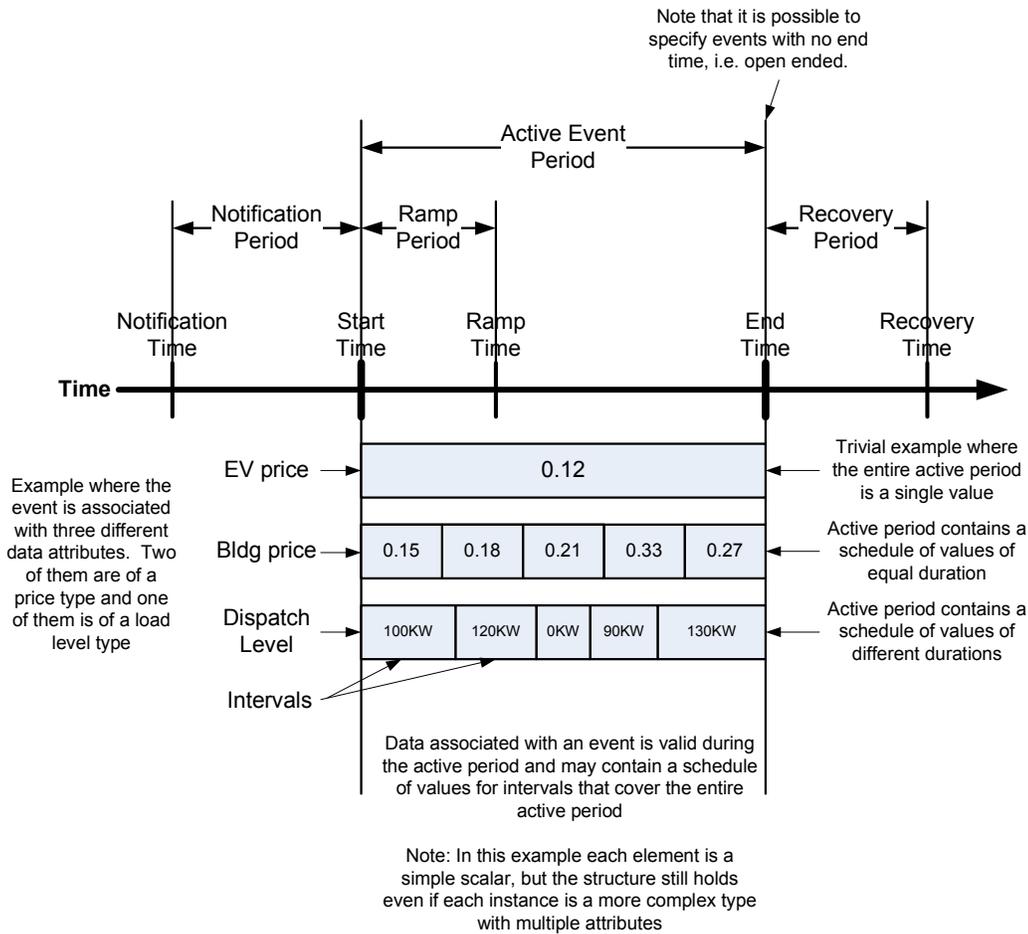
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529 3.4.1 Temporal Model of a DR Event

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

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

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



541

542

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

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543

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544 3.4.2 DR Event - Data Requirements

Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>4</sup>	Map to SEP 2.0 TRD
	<b>All DR Events</b>				
DR Program Name	An identifier of the program for which a DR event was issued.	DR Program Name	Program Name	EventState.progra mName	DR event name
Service Provider ID	An identifier for the Service Provider issuing the DR event.	Service Provider ID	(System Operator)	EventState.drasNa me	
Event ID	An identifier for the DR event that was created when the DR event was first issued.	Event ID	Event ID	EventState.eventI dentifier	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	n/a	EventState.event ModNumber	
Location Identifier	An identifier used to indicate what this dispatch is applicable to. A value of "null" indicates that the price is in effect for all areas.	Location			

<sup>4</sup> 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)		Map To		
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>4</sup>
Data Element	Description			
Location-type	A value used to interpret the value contained in the Location. Examples of Location-type include: Postal Address Zone GPS Coordinates Grid Location / USNG Electrical Node Zip-code Weather Station Zone ID Zone (from CIM) Electrical Node ID (could be the same as Service Delivery Location) Electrical Node Name Electrical Node Type PNode PNode ID, Competitive Choice Area  Or Resource Identifier Or Asset Identifier	Location-type	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, Competitive Choice Area	
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	Deployment Type=test or Audit	EventState.testEvent

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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)		Map To																								
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>4</sup>	Map to SEP 2.0 TRD																					
Data Element	Description																									
Simple Signal Levels	Used as an alternate and simplified representation of the DR signal, whether it be price based or a dispatch. Takes on a small number of finite levels such as NORMAL, MODERATE, and HIGH, SPECIAL		n/a	EventState:simple DRModeData:OperationModeValue  EventState:simple DRModeData:OperationModeSchedule																						
Criticality Level	This field defines the level of criticality of this event. The action taken by load control devices for an event can be solely based on this value, or combination with other Load Control Event fields supported by this device. For example, additional fields such as Average Load Adjustment Percentage, Duty Cycle, Cooling Temperature Offset, Heating Temperature Offset, Cooling Temperature Set Point or Heating Temperature Set Point can be used in combination with the Criticality level. <b>Criticality Level Description Participation</b> <table border="0"> <tr><td>0</td><td>Reserved</td></tr> <tr><td>1</td><td>Green</td></tr> <tr><td>2</td><td>Voluntary</td></tr> <tr><td>3</td><td>Voluntary</td></tr> <tr><td>4</td><td>Voluntary</td></tr> <tr><td>5</td><td>Voluntary</td></tr> <tr><td>6</td><td>Voluntary</td></tr> <tr><td>7</td><td>Emergency Mandatory</td></tr> <tr><td>8</td><td>Planned Outage Mandatory</td></tr> <tr><td>9</td><td>Service Disconnect Mandatory</td></tr> <tr><td>0x0A to 0x0F</td><td>Utility Defined</td></tr> </table>	0	Reserved	1	Green	2	Voluntary	3	Voluntary	4	Voluntary	5	Voluntary	6	Voluntary	7	Emergency Mandatory	8	Planned Outage Mandatory	9	Service Disconnect Mandatory	0x0A to 0x0F	Utility Defined			Criticality Level
0	Reserved																									
1	Green																									
2	Voluntary																									
3	Voluntary																									
4	Voluntary																									
5	Voluntary																									
6	Voluntary																									
7	Emergency Mandatory																									
8	Planned Outage Mandatory																									
9	Service Disconnect Mandatory																									
0x0A to 0x0F	Utility Defined																									
<b>All Price Plus Information Dispatches</b>																										

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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)		Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>4</sup>	Map to SEP 2.0 TRD
Data Element	Description				
DR Dispatch Type (for Price Plus)	Identifies the type of the DR Price Plus Dispatch. PRICE_ABSOLUTE - Price number PRICE_RELATIVE - Change in price relative from base tariff. PRICE_MULTIPLE - Multiple of current price	Instruction Type	n/a Retail only for now	EventState.drEventData.eventInfoInstances.eventInfoTypeID  EventState.DrEventData.eventInfoInstances.eventInfoName	
Currency	<b>All Price Plus Information Intervals</b> 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		EventState.DrEventData.eventInfoInstances.eventInfoValues.value	
Unit-of-Measure	Indicates the unit of measure for which the price pertains. MUST be compliant with the International System of Units as defined by NIST SP 330, ref: <a href="http://physics.nist.gov/Pubs/SP330/sp330.pdf">http://physics.nist.gov/Pubs/SP330/sp330.pdf</a> Examples of NIST compliant units of measure include: kWh MWh	Unit-of-Measure	type of attribute	EventState.DrEventData.eventInfoInstances.eventInfoTypeID	
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	Uses Start and End Times		

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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)		Map To		
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>4</sup>
Data Element	Description			
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	Start Time	EventState.drEventData.startTime/endTime/notificationTime
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	Program ID & Program Name	EventState.drEventData.eventInstances.eventInfoValues.timeOffset
DR Dispatch Type (for Objectives)	<b>All DR Objective Dispatches</b> Identifies the type of DR Objectives: <ul style="list-style-type: none"> <li>LOAD_LEVEL</li> <li>LOAD_AMOUNT</li> <li>LOAD_PERCENTAGE</li> </ul>	Dispatch Instructions	Deployment MegaWatts	EventState.drEventData.eventInstances.eventInfoTypeID  EventState.drEventData.eventInstances.eventInfoName
	<b>All DR Objective Intervals</b>			

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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)		Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>4</sup>	Map to SEP 2.0 TRD
Data Element	Description				
Interval Start Time	Start time of the dispatch interval.	Event Schedule	Event Day Event Start Time Event End Time	EventState.drEventData.startTime EventState.drEventData.eventInfoValues.timeOffset	
Interval Duration	Period of time the Control Command is in effect.		Use Start/End		
Load Level Value	<b>All DR Load Level Objective Intervals</b> <b>DR Dispatch Type = "LOAD_LEVEL"</b> Value of the load level to be achieved based on a set of enumerated values. (i.e. moderate, high, etc)	Dispatch Instructions	n/a	EventState.drEventData.eventInfoValues.value	
Load Amount Value	<b>All Load Amount Level Objective Intervals</b> <b>DR Dispatch Type = "LOAD_AMOUNT"</b> Fixed amount of load to shed in kW.	Dispatch Instructions	Energy Schedule or Ancillary Service Product Schedule	EventState.drEventData.eventInfoValues.value	
Load Percent Value	<b>All Load Percentage Objective Intervals</b> <b>DR Dispatch Type = "LOAD_PERCENTAGE"</b> Percentage of load to increment or shed.	Dispatch Instructions Dispatch Instructions	Deployment MegWatts as percentage.	EventState.drEventData.eventInfoValues.value	Average Load Adjustment Percentage (expressed as signed integer, e.g. -10 is 10% reduction from average load)

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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)		Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>4</sup>	Map to SEP 2.0 TRD
Data Element	Description				
DR Dispatch Type	All Direct Load Control Dispatches Direct Load Control is a Dispatch type that requests an Asset to be in a specific load control state (e.g., to turn it on or off). Identifies the objective type as Direct Load Control.				
DR Asset ID	An identifier of the DR Asset for which the control is intended.	DR Dispatch Type	n/a		
Status Check	A signal to require the DR resource status to be sent back.	DR Asset ID	n/a	EventState.drasClientID	HAN Device ID
Direct Load Control Type	All Direct Load Control Intervals The type of DR Direct Load Control Command: e.g. Set Point Open/Close Heating Temperature -offset/setpoint Cooling Temperature -offset/setpoint Load adjustment offset	Status Check	n/a		SEP 2.0 Req[DRLC-3] No specific data requirement
Direct Load Control Value	Value associated with the Direct Load Control Type.	DR Control Command			Heating Temperature (offset/setpoint), Cooling Temperature (offset/Setpoint), Load adjustment offset

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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)		Map To		
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>4</sup>
Data Element	Description			
Interval Start Time	Start time of the dispatch interval.	Event Schedule		DR event start date/time
Interval Duration	Period of time the Control Command is in effect.			DR event duration
Duty cycle	“Duty Cycle (optional): Defines the maximum On state duty cycle as a percentage of time. Example, if the value is 80, the device would be in an “on state” for 80% of the time for the duration of the event. Range of the value is 0 to 100. A value of 0xFF indicates the field is not used.” <sup>5</sup>		EventState.drEventTime/notifications.eventInfoValues.timeOffset	Duty cycle
Event control	Event Control options for randomized start or end times: 1= Randomize Start time, 0=Randomized Start not Applied 1= Randomize End time, 0=Randomized End not Applied. 5			Event control

<sup>5</sup> Smart Energy Profile Specification ZigBee Profile: 0x0109 Revision 1.5, December 1, 2008

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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)		Map To		
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>4</sup>
Data Element	Description			
Device Class	Enumeration representing the Device Class to apply the current Load Control Event. 0 HVAC compressor or furnace 1 Strip Heaters/Baseboard Heaters 2 Water Heater 3 Pool Pump/Spa/Jacuzzi 4 Smart Appliances 5 Irrigation Pump 6 Managed Commercial & Industrial (C&I) loads 7 Simple misc. (Residential On/Off) loads 8 Exterior Lighting 9 Interior Lighting 10 Electric Vehicle 11 Generation Systems 12 to 15 Reserved Footnote: <sup>5</sup>			Device Class

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**3.4.3 Notify DR Event - Data Requirements**

Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>6</sup>	Map to SEP 2.0 TRD
Event Status	<b>Notify DR Event includes all of the elements of Event with the following additional elements.</b> Gives the current status of an upcoming or active event.		n/a	EventState.simpleDRMode Data.EventStatus FAR, NEAR, ACTIVE	
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	Event Status	EventStateven tModNumber	
Modification reason code	The reason the event was modified.	Modification reason code			
Cancellation reason code	The reason the event is being cancelled.	Cancellation reason code	n/a		DR event cancel control
(Cancel) Effective date/time	The date and time a cancellation takes effect.	(Cancel) Effective date/time	n/a		Cancel effective date/time
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		

<sup>6</sup> Abbreviation for *OPEN AUTOMATED DEMAND RESPONSE COMMUNICATIONS SPECIFICATION*

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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.		Map To			
Data Element	Description	PAP09 Retail	PAP09 Wholesale Energy Baseline Timestamp	OADRCS <sup>6</sup>	Map to SEP 2.0 TRD
Energy Baseline Timestamp	Timestamp of Energy Baseline				

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3.4.4 Asset / Resource Status (State) – Data Requirements

Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>7</sup>	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: <ul style="list-style-type: none"> <li>Faults in device</li> <li>Customer override.</li> </ul>	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			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: <ul style="list-style-type: none"> <li>Location of Asset, either geographic or grid location</li> <li>Asset schedule of participating Asset load profile (schedule).</li> </ul>	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		EventStateConfirmation	

<sup>7</sup> 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.		Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>7</sup>	Map to SEP 2.0 TRD
Data Element	Description				
Opt in/out	<p>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:</p> <ul style="list-style-type: none"> <li>• All events in a program indefinitely</li> <li>• Specific DR Event</li> <li>• All events in a specific time period.</li> </ul> <p>In addition, there may be a schedule associated with the opt in/out state.</p>	Opt in/out	EventStateConfirmation.OptInState  Also separate service for OptOutState	Req[DR.LC-1] No specific data requirement	
Usage Information	Information about the near real time electricity usage of the DR Resource.	Usage Information			

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553 3.4.5 DR Resource – Data Requirements

Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>8</sup>	Map to SEP 2.0 TRD
DR Resource Identifier	This identifies the DR Resource that is being registered.	DR Resource Identifier	Resource ID		
DR Resource Enrollment (Registration) Transaction 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: <ul style="list-style-type: none"> <li>REGISTRATION (to register a new asset/resource)</li> <li>CHANGE (refers to permanent changes)</li> <li>RETIREMENT.</li> </ul>	Report-type			
Resource Type	Type of Resource. Valid types are: load reduction, generation, combination.		Resource Type- DR from load reduction, generation, combination		
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	
Demand Response Provider	The entity that is responsible for delivering Demand reductions from Demand Resources and is compensated for providing such Demand Response products in accordance as specified by the System Operator.				
DR Resource Group ID	Grouping of Resources that can respond to the same DR Signal.				
<b>The following attributes are used for a DR Resource to enroll in a DR Program.</b>					
DR Program Identifier	This identifies the DR program in which a DR Resource is participating.	DR Program Identifier	Program ID	program	

<sup>8</sup> 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.		Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>8</sup>	Map to SEP 2.0 TRD
Data Element	Description	PAP09 Retail	PAP09 Wholesale	OADRCS <sup>8</sup>	Map to SEP 2.0 TRD
DR Resource Operational Constraints	<p>These are constraints that define the amount load that can be made available during a DR event and includes the following:</p> <ul style="list-style-type: none"> <li>• Minimum load</li> <li>• Maximum load.</li> <li>• Maximum-Duration</li> <li>• Minimum-Duration</li> </ul>	DR Resource Operational Constraints; Maximum-Duration Minimum-Duration	<p>Limits: Limit Value Limit Type Physical Min Gen Min Gen MW Ramp Rate Type Ramp Rate Segment Ramp Rate Direction (offer parameter section 8)</p>	programConstraint maxEventDuration	
DR Resource Schedule Constraints	<p>These are a set of constraints that specify when the DR Resource will be available. It may contain such information as:</p> <ul style="list-style-type: none"> <li>• Time of day schedule constraints</li> <li>• Black out dates</li> <li>• Maximum consecutive days of participation</li> <li>• Maximum duration of DR event participation</li> <li>• Minimum duration of DR event participation</li> <li>• Max number of times per day the DR Resource may be called</li> <li>• Minimum advanced notification necessary.</li> </ul> <p>Provide details if DR asset or DR resource is in any other DR programs (wholesale and retail)</p>	DR Resource Schedule Constraints	<p>Operational Constraints: OC Type OC Value OC Interval</p>	programConstraint	
Effective-Start-Date-Time	The start date and time which an asset/resource is available.	Effective-Start-Date-Time	Effective Enrollment Date	programConstraint	
Location	An identifier to indicate the location of the asset/resource.	Location		locationInformation	

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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.		Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>8</sup>	Map to SEP 2.0 TRD
Location-type	<p><b>Description</b></p> <p>A value used to interpret the value contained in the Location element. Examples of Location-type include:                      (Postal) Address                      Zone                      GPS Coordinates                      Grid Location / USNG                      Electrical Node                      Zip-code</p>	Location-type	PAP09 Wholesale 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		

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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.		Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>8</sup>	Map to SEP 2.0 TRD
<b>Data Element</b>	<b>Description</b>				
Response-time (Ramp 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			
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	Nominal capacity (decimal) Qualified Capacity Value Capacity Type & Description		
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: <ul style="list-style-type: none"> <li>• All events in a program indefinitely</li> <li>• Specific DR Event</li> <li>• All events in a specific time period.</li> <li>• Other triggered programs for which an asset or DR resource is already called upon (reduce double counting of available capacity)</li> </ul>	Temporary Opt-Out	No equivalent	OptOutState	
Resource Type	Type of Resource. Valid types are: load reduction, generation, combination.		Resource Type- DR from load reduction, generation, combination		
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		
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		

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554 3.4.6 DR Asset – Data Requirements

Data Element		Description	Map To			
			PAP09 Retail	PAP09 Wholesale	OADRCS <sup>9</sup>	Map to SEP 2.0 TRD
DR Asset Identifier		The unique identifier and name of the DR Assets.	DR Asset Identifier	No equivalent concept of DR Asset	EventState.dra sClientID	
DR Asset Enrollment (Registration) Transaction 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: <ul style="list-style-type: none"> <li>REGISTRATION (to register a new asset/resource)</li> <li>CHANGE (refers to permanent changes)</li> <li>RETIREMENT.</li> </ul>	Report-type			
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. This is the entity that has physical control of the asset and control of the capability to participate in DR Events.	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		location information	
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			

<sup>9</sup> Abbreviation for *OPEN AUTOMATED DEMAND RESPONSE COMMUNICATIONS SPECIFICATION*

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Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>9</sup>	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. An Asset can associate with multiple Resources, but with only one Resource for a DR Program.	DR Resources			

555

556

3.4.7 Demand Response Customer Enrollment – Data Requirements

557

Data Element	Description	Map To			
		PAP09 Retail	PAP09 Wholesale	OADRCS <sup>10</sup>	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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<sup>10</sup> Abbreviation for OPEN AUTOMATED DEMAND RESPONSE COMMUNICATIONS SPECIFICATION

560 **3.5 OpenADR Technical Architecture View**

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

566 3.5.1 Networking Standards

- 567 1. OpenADR services SHALL be provided via TCP/IP (internet) networks. (See [RFC-1122])  
568 2. OpenADR services SHALL be exposed primarily using the HTTPS protocol. (See [RFC-1123])  
569 3. OpenADR services MAY support Secure FTP. Since OpenADR requires HTTPS, FTP is only an  
570 option if both parties implement and agree to use FTP. (*Note that requiring support is in*  
571 *discussion.*)

572 3.5.2 Security Standards

573 A major component of OpenADR is ensuring that protected resources, including data, can and will be  
574 secured to prevent unauthorized access. To ensure that data is not provided to unauthorized parties, the  
575 constraints and controls documented in *SECURITY PROFILE FOR THIRD PARTY DATA ACCESS*  
576 [[ASAP-SG-3P](#)] are to be complied with for OpenADR installations.

577 Using the terminology specified in the ASAP-SG Third Party Data Access document, the customer is  
578 the Resource Owner, the Data Service Provider is the Resource Custodian. (The 3<sup>rd</sup> Party is still called  
579 the Third Party)

580 3.5.3 Service / Resource Patterns

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

583 The OpenADR services naming convention has the following rules:

- 584 • **Information Object** – Collection of entities (classes and attributes) to describe an object in a  
585 business context.
- 586 • **Service / Resource Name** – Service naming convention follows the information object in a  
587 business process for an interface definition.
- 588 • **Service Patterns** -These patterns are used for Web services naming convention.
- 589 • **Send** – to provide (send) information (business object) for public (enterprise)  
590 consumption. To be invoked by the system of record for the business object and only  
591 when the state of the business objects has been changed.
- 592 • **Receive** – to consume (receive) information (business object).

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- 593
- **Request** – to request another party to perform a specific service
  - 594
  - **Execute** – to run a service provided to the public, which may include a state change  
595 request or a query request.
  - 596
  - **Reply** – to reply with the result of the execution of a service (by the Execute service)
  - 597
  - **Show** – to provide (show) information (business object) for public (enterprise)  
598 consumption, when the state of the business object is not changed, by the system of  
599 record or other system that has a copy of the same business object.
  - 600
  - **Retrieve** – to request specific data of a business object to be provided.
  - 601
  - **Publish** – to provide (send) information (business object) for public (enterprise)  
602 consumption. To be invoked by the system of record for the business object and only  
603 when state of a business object has changed.
  - 604
  - **Subscribe** – to consume (receive) information (business object) from an external  
605 source.

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

609 The following verbs are used for service/operation provided by the master system that owns  
610 the Information Object to entertain the request for the specified action implied by the verb.

- 611 ▪ **Create**
- 612 ▪ **Change**
- 613 ▪ **Cancel**
- 614 ▪ **Close**
- 615 ▪ **Delete**

616 The following verbs are used for service/operation provided by systems that are interested in  
617 receiving the Information Object as the result of the specified action implied by the verb.  
618 This can be invoked by the master system or an intermediary to supply the Information  
619 Object.

- 620 ▪ **Created**
- 621 ▪ **Changed**
- 622 ▪ **Closed**
- 623 ▪ **Canceled**
- 624 ▪ **Deleted**

625 The following verbs are used for query type services provided by the master system of the  
626 Information Object.

- 627 ▪ **Get**
- 628 ▪ **Show**

629 The following verbs may be used within OpenADR.

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630

- **Subscribe**

631

- **Unsubscribe**

632

633 **3.6 Governance**

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

- 639 1. Changes shall be made to be backwards compatible (optional additions only), to allow existing  
640 implementations to continue to operate.
- 641 2. Participants are encouraged to submit extensions to the working group as business requirements,  
642 with additional recommendations as necessary, to be discussed, ratified, and added to periodic  
643 updates.

644 **4 Appendices**

645 **4.1 Terms and Definitions**

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

Term	Definition
<b>Advanced Metering Infrastructure (AMI)</b>	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.
<b>Aggregator</b>	Intermediary that manages a collection or “aggregation” of Demand Response by Utility Customers. Also known as Curtailment Service Provider.
<b>[DR] Asset Owner</b>	The entity that is responsible for the DR Resource or Asset in the retail market.
<b>Ancillary Services</b>	Ancillary services are those functions performed by electrical generating, transmission, system-control, distribution equipment and customers to support the integrity of the bulk power system.
<b>Curtailment Service Provider</b>	See Aggregator.
<b>Demand Response</b>	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.
<b>Demand Response Program</b>	A Demand Response Program is a program that is created to provide incentive to customers to reduce or shift demand.
<b>Demand Response Provider (DRP)</b>	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)
<b>Direct Load Control</b>	Direct Load Control is a Dispatch type that requests an Asset to be in a specific load control state (e.g., to turn it on or off).
<b>IEC</b>	The International Electrotechnical Commission (IEC). The IEC TC57 maintains an electric utility focused information model called CIM (Common information model).
<b>IEC 61968</b>	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.
<b>Logical Data Model</b>	A representation of an organization’s data based upon entities and attributes of those entities. A logical data model is often a logical representation of a business’ integration or business requirements.
<b>SLA</b>	Service Level Agreement: the part of a service contract where the level of the

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Term	Definition
	services are agreed upon between two systems.

647

648

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649 **4.2 Integration Services – Detailed Messages by Use Case**

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

653 The source of the requirement is defined in the “Requirements Source” column. Since the Service names  
654 are based the PAP09 Retail and OpenADR Use Case documents, only the remaining requirements  
655 sources are cited individually.

656 Each service is assigned a priority within the current release or defined for a future release as defined in  
657 the “Priority/Release” column.

658

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 <sup>11</sup> 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	The Asset is updated.		

<sup>11</sup> Abbreviation for *OPEN AUTOMATED DEMAND RESPONSE COMMUNICATIONS SPECIFICATION*

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Use Case Scenario	Service Name	Provider	Functional Description of the Service	Priority/Release	Requirements Source
		Entity			
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 Information		OADRCS 7.1.1
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 <sup>12</sup> 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		SEP2TRD 10.4

<sup>12</sup> Abbreviation for ZigBee Smart Energy Profile™ 2.0 Technical Requirements Document

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Use Case Scenario	Service Name	Provider	Functional Description of the Service	Priority/Release	Requirements Source
			result of the DR Asset receiving a DR signal or it may be conducted continuously.		
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 Pricing (RTP) / Dynamic Price Based	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 <sup>13</sup> -UC-19,ID3
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) /	Suggested Schedule Adjustment	UDC	UDC sends suggested schedule adjustments based on circuit limits. (Process for reprocessing schedule is not defined)		

<sup>13</sup> Abbreviation for *Energy Information Standards (EIS) Alliance Customer Domain Use Cases*

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Use Case Scenario	Service Name	Provider	Functional Description of the Service	Priority/Release	Requirements Source
Dynamic Price Based					
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		
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	DR	DR	DR Controlling Entity provides DR		

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<b>Use Case Scenario</b>	<b>Service Name</b>	<b>Provider</b>	<b>Functional Description of the Service</b>	<b>Priority/Release</b>	<b>Requirements Source</b>
Execution – Direct Load Control (DLC)	Capability Aggregated by Network Location	Controlling Entity	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 (DLC)	Suggested Schedule Adjustment	UDC	UDC sends suggested schedule adjustments based on circuit limits to DRP. (Process for reprocessing schedule is not defined)		
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	Request Meter Read	LSE	LSE requests meter read from Customer Resource		

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<b>Use Case Scenario</b>	<b>Service Name</b>	<b>Provider</b>	<b>Functional Description of the Service</b>	<b>Priority/Release</b>	<b>Requirements Source</b>
(Open Retail)					
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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