# Demand Response Analysis and Control System

# Use Cases and Requirements

**Prepared For:**
California Institute for Energy and Environment
University of California Office of the President

**In Response To:**
Research Opportunity Notice DR ETD-02-01

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November, 2008

# Document History

## Revision History

| Revision Number | Revision Date | Revision / Reviewed By | Summary of Changes | Changes marked |
|---|---|---|---|---|
| 0.1 | 122908 | Stuart McCafferty | Original Document | N |
| 0.9 | 01/17/09 | Jerry Melcher | Revisions | Y |
| 1.0 | 01/19/09 | Stuart McCafferty | Final Document | N |
| 1.1 | 01/22/09 | Jerry Melcher, Glenn Allgood | Final Document with Comments | Y |
| 1.2 | 1/23/09 | Stuart McCafferty | Final Document | N |
| 1.3 | 2/09/09 | Stuart McCafferty | Revisions from CIEE/CEC | N |
| | | | | |

## Approvals

This document requires following approvals.

| Name | Title |
|---|---|
| Gaymond Yee | CIEE Program Manager |
| Erich Gunther | EnerNex Chief Engineer |

# Contents

# 1. Introduction and Background

## 1.1 Document Context

This document meets the deliverable requirement for Task 1, Develop Requirements for a Demand Response Analysis and Control System (DRACS) for the California Institute for Energy and Environment's (CIEE) grant for Research Opportunity DR ETD-02-01. The grant was provided to the EnerNex team to address two research topics and questions identified in the opportunity notice:

- *"Using a military (or another, such as air traffic control) C3I system as a model, adapt it to conceptually deal with C2I electricity applications such as dispatching DER to keep the lights on. Compare and contrast the chosen C3I model with the requirements for implementing a C²I strategy for integrating utility information and communications systems. Are there analogies that indicate utilities can operate in a similar fashion? If not, what are the gaps that need to be filled and is it feasible to fill the gaps?*
- *Given current utility systems and assuming the systems are integrated, how would the CAISO or an UDC operate its control centers in a military (or another) C3I style? With up-to-date real-time information and the ability to control all of its available assets, given a particular operational scenario, how would a plan to address the scenario be executed using strategies based on military (or another) C3I?"*

The requirements identified in this document are based on careful studies of existing demand response Use Cases originally created by Southern California Edison (SCE), interaction with CAISO and multiple California Independent Service Operator (ISO) stakeholders, and coordinated efforts between EnerNex Demand Response experts, the AMI-ENT team[1], California IOUs, various standards development organizations, and C3I system engineers at Oak Ridge National Laboratories (ORNL).

## 1.2 Background

California is poised to implement a widespread demand responsive energy grid that includes a variety of technologies and tariffs as well as regulatory and social influences. If widely deployed, such a system would closely couple power system, communication, "societal behavior" networks, with estimates of social resiliency in such a way that the nonlinearities embedded in these systems may result in unforeseen interactions and chaotic behavior.

There exists an urgent need to understand and manage the overall complex system behavior of a demand responsive energy grid in order to provide real time (and faster than real time[2]) monitoring, analysis, and control. This "understanding" must support aggregate behavior anticipation

[1] The AMI-ENT team, or AMI Enterprise Task Force defines requirements, policies, and services, based on utility industry standards such as the Common Information Model (CIM), required for informatin exchange and control between the Meter Data Manaagement System (MDMS) and enterprise back office systems.

[2] Faster than real time simulation (FRTS) are systems that are capable of operating at speeds that advance faster than world time. When simulators can operate at these speeds, experiments and predictions can be performed to keep real time control systems ahead of the anticipated response of the actual system.

and analysis in terms of location of loads and utility assets, electrical grid and communication network topology, as well as cost structures and tariffs, information flow across the communications network and energy grid, and the resulting coupled control linkages.

The primary contributor to improved system performance is the ability to accurately predict in real-time the total amount of equivalent dispatchable resource available through DR – in essence a comprehensive Demand Response Analysis and Control System (DRACS). In this context, DR includes load management due to:

- pricing signhide robbals
- direct load control
- interruptible loads
- and distributed resources.

Improved performance results by understanding the reliability and stability of the power and communication systems at all times, and then using that information to achieve specific performance goals. DRACS is the proposed solution for providing this situational awareness and analytical capability and is one of the primary software modules within an integrated Demand Response Management System (DRMS).

## 1.3 Assumptions

Assumptions

- When appropriate, in addition to meeting the requirements described within this document, the system designer/implementer must also be compliant with ALL appropriate standards organizations' terminology, interoperability, and messaging. This includes:
  - IEC 61968 Application integration at electric utilities – System interfaces for distribution management.
  - IEC 61970 Application integration at electric utilities – Energy management system application program interface (EMS-API).
  - North America Energy Standards Board (NAESB) Demand Side Management and Energy Efficiency (DSM-EE) standards – (coming soon – NAESB is the "stakeholder" arm at FERC). Business practices to support demand side management and energy efficiency programs in the wholesale and retail electric markets.
  - NERC DR standards – coming soon
- The DRACS system is the situational understanding module within the overall DRMS system.
- Existing T&D topology data is already in existence and can be utilized by the DRACS system.
- The DRACS system includes the following high level components.
  - Relational database of Demand Resources and behavior
  - Scenario analyzer/Baseline tool
  - Visualization of DR topology and real time network information

- This requirements document was primarily developed for California ISO, utilities, and aggregators. However, the requirements are intentionally generic enough to apply to other states.

# 2. The DRACS System

## 2.1 Situational Understanding

The DRACS module is responsible for the *situational understanding* of the demand response environment. The Department of Defense defines Situational understanding as the product of applying analysis and judgement to the DRMS situational awareness to determine relationships of the factors present and form logical conclusions concerning threats (risks in this point in time), opportunities to effect demand reduction value (mission), and gaps in information. In other words, DRACS must support a real time assessment capability that provides detailed and accurate information on the entire demand responsive network topology. In addition, past behavior and historic patterns are part of the "understanding" necessary to understand current capabilities and system response expectations. DRACS situational awareness includes:

- Current electrical network activity. This real time network activity includes awareness of weather, outages, voltage loss, congestion, or other pertinent information which can affect the ability to support a DR request. In addition, this information can be used to help predict the effectiveness of a DR request against a subset of DR customers or help to target the DR request to customers/locations capable of supporting the DR request more effectively.
- Existing demand response topology and historical behavior. Each active Demand Resource, its potential DR capacity, and historical behavior patterns must be understood in order to develop effective DR request scenarios and implementation strategies. Demand Resources may be load managing, supply managing, or both. Customers' behavior, such as percentage of time they "opt out" of DR events and amount of DR capacity supported in DR events, are important variables in predicting future behavior and in calculating a Baseline and the total expected response from each Demand Resource (or customer).

Increased visibility of performance data, ongoing monitoring of DR systems and resources, and the consistency of customer responses will be examined for their contribution to the effectiveness of the DRMS system through DRACS.

## 2.2 Demand Resource Services

In general, Demand Resources are measures that reduce consumer demand for electricity from the bulk power system, such as using energy-efficient appliances and lighting, advanced cooling and heating technologies, electronic devices to cycle air conditioners on and off, and equipment to shift load to off-peak hours of demand. They also include using Distributed Generation (DG). Demand response occurs in wholesale electricity markets when market participants reduce their consumption of electric energy from the network in exchange for compensation based on wholesale market prices.

Demand Response is a temporary change in electricity consumption by a ***Demand Resource*** in response to market or reliability conditions. For purposes of these requirements, Demand Response does not include energy efficiency or permanent Load reduction.

A Demand Resource is a Load or aggregation of Loads capable of measurably and verifiably providing Demand Response. Demand Resources can support four (4) types of services, which must be included as an attribute (or property) within the DRACS relational database.

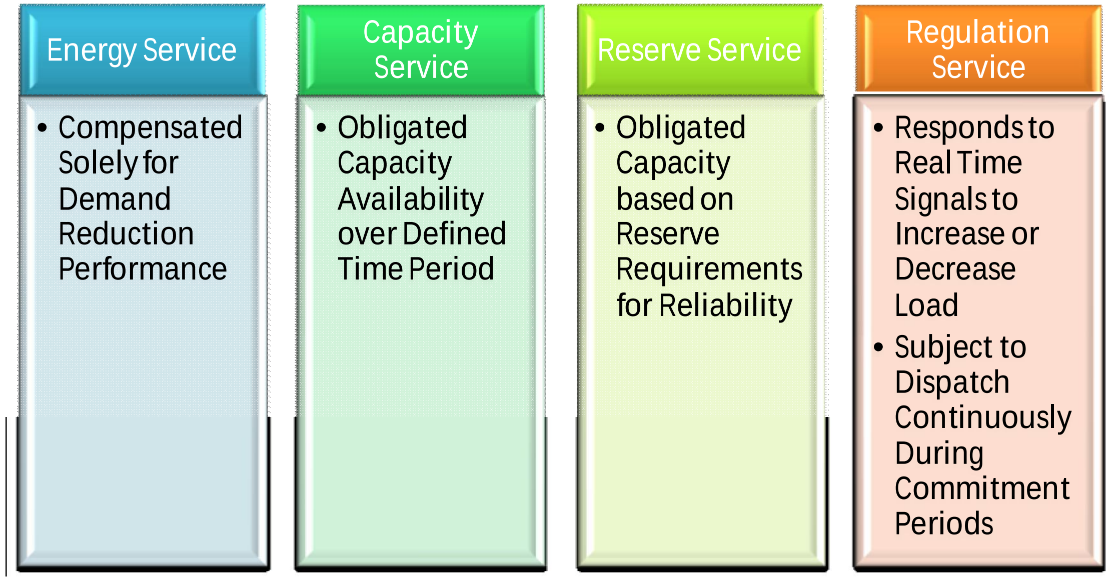


**Figure 2-1: Four Types of Demand Resource Services (ref: NAESB//NERC)**

1. Energy Service - A type of Demand Response service in which Demand Resources are compensated based solely on Demand reduction performance.
2. Capacity Service - A type of Demand Response service in which Demand Resources are obligated over a defined period of time to be available to provide Demand Response upon deployment by the System Operator.
3. Reserve Service - A type of Demand Response service in which Demand Resources are obligated to be available to provide Demand reduction upon deployment by the System Operator, based on reserve capacity requirements that are established to meet applicable reliability standards.
4. Regulation Service - A type of Demand Response service in which a Demand Resource increases and decreases Load in response to real-time signals from the System Operator. Demand Resources providing Regulation Service are subject to dispatch continuously during a commitment period. Provision of Regulation Service does not correlate to Demand Response Event timelines, deadlines and durations.

## 2.3 Demand Resource Baseline

DRACS relies on its situational understanding to calculate the “Baseline” model. A Baseline is an estimate of the electricity that would have been consumed by a Demand Resource in the absence of a Demand Response Event. Baseline is compared to the actual metered electricity consumption during the Demand Response Event to determine the Demand Reduction Value. Depending on the type of Demand Response product or service, Baseline calculations may be performed in real-time or after-the-fact.

There are three (3) types of baseline estimates which will be supported by DRACS.

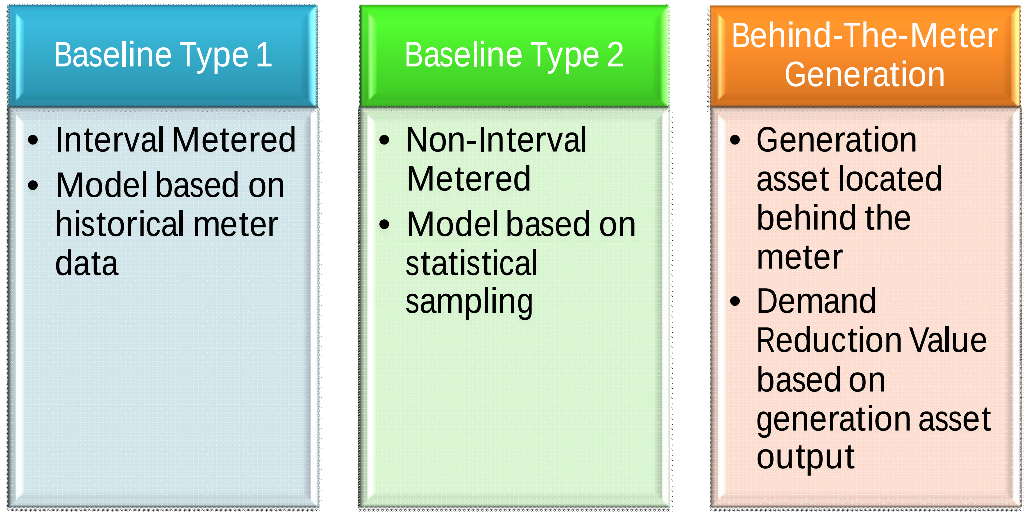


**Figure 2-2: Three Types of Baseline Models**

1. Baseline Type 1 (Interval Metered) - A Baseline model based on a Demand Resource's historical interval meter data which may also include but is not limited to other variables such as weather and calendar data.

2. Baseline Type 2 (Non-interval Metered) - A Baseline model that uses statistical sampling to estimate the electricity consumption of an Aggregated Demand Resource where interval metering is not available on the entire population.

3. Behind-The-Meter Generation - A performance evaluation methodology, used when a generation asset is located behind the Demand Resource's revenue meter, in which the Demand Reduction Value is based on the output of the generation asset. Distributed generation resources are considered "behind-the-meter" generators, such as combined heat and power (CHP) systems, wind turbines, and photovoltaic generators that generate electricity on site.

## 2.4 DRACS High Level Functionality

In order to accomplish the situational awareness requirements, DRACS must support the following functionality:

1. Observe (and visualize) real time network information network-related events (outages, voltage loss, etc.). This real time functionality is necessary in order to provide visual feedback of current relevant events and the overall real time DR topology.
2. Load and maintain database of demand responsive resources. A comprehensive, accurate list of Demand Resources must be maintained in order to provide the DR event predictive capabilities necessary in the DRMS system. The database must be scalable and built to support 100's of thousands or even millions of resources. In addition, DRACS will provide a visualization tool for the Demand Resource

topology. The visualization component will provide the operator the ability to drill up and down to different levels within the DR topology, providing functionality similar to "Google Map".

3. Load and maintain database of demand responsive behavioral information. Each Demand Resource (or customer) historical response to DR requests must be captured for use in predicting future behavior. This information will be stored in a relational database and will be updated frequently to ensure optimal predictive information.
4. Receive and analyze scenarios for compliance with DR requests. DRACS will receive "scenarios" from other modules within the DRMS system, which have been created based on the organization's business rules. These scenarios will provide a desired load response, the timeline involved, and a set of DR customers and resources. These scenarios will be evaluated by the DRACS system to determine the likelihood (probability of meeting the demand) of success in meeting the DR load response objective. DRACS will achieve this capability by employing standard network and historical pattern prediction algorithms and through analysis of customer behavior in responding to previous DR events.

## 2.5 DRACS Conceptual Components

The DRACS system can be viewed as a sub-system or module within the DRMS system. It is responsible for real time situational awareness and the current DR topology.

This document is intended to be used to help system designers and implementers by calling out the specific requirements that need to be met for a successful DRACS system. However, it is difficult to discuss a system without a high level understanding of how the system will look and operate. The following component discussion and diagram are for illustrative purposes only, with the overall intent of providing the reader with an understanding of how the authors envision the DRMS architecture providing the functionality necessary for success. It is not intended to limit the reader in providing his own component naming conventions or to develop a completely different architecture – as long as it meets the overall system requirements discussed later in this document.

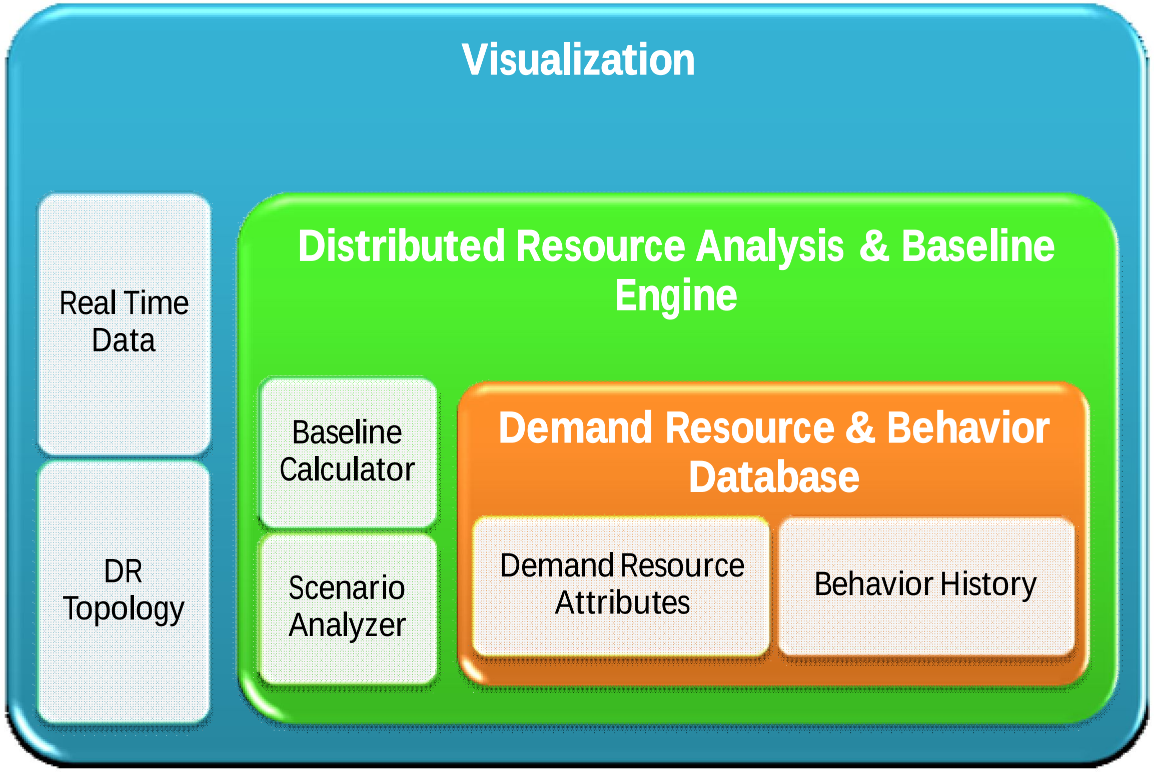


**Figure 2-3: DRACS Conceptual Components**

There are three (3) primary components within the conceptual DRACS architecture depicted in the figure above:

1. Demand Resources and behavior database – this relational database houses Demand Resource information such as the device type, service type, customer ID, path/topology information, enrolled customer programs, maximum load, normal load, GPS location, and any other attributes pertinent to understanding the location and load profile of the resource. In addition, the database also houses behavioral patterns of the resource based on historical data. In addition, DR event data is stored to understand the system's expected response vs. the actual response for each DR event. The existence and required maintenance of this database implies an import capability that periodically captures behavior, and provides a mechanism for adding and removing Demand Resources.
2. Distributed Resource Analysis and Baseline Engine – this analytical tool is the heart of the DRACS system. It receives a scenario from the DRMS system, analyzes the scenario requirements against the Baselines, historical behavior, and real time conditions, and then returns the likelihood of success to the DRMS system.

3. Visualization – the visualization component provides the operator with a real time topological view of the demand response landscape. It also provides the operator with a view of real time network events and a drill up/down capability for any Demand Resource that exists in the DR topology.

# 3. DRACS Use Cases

The high level functionality described in section 2.4 above provide the baseline for the use cases chosen for this document, and ultimately drive the requirements defined within. These use cases will be described in more detail in subsequent sections, but are described briefly below:

1. DRACS monitors and stores real time network information. This exercises the monitoring of real time network data and coordination with network events.
2. DRACS manages information on demand responsive resources. This exercises the addition and removal of the Demand Resource from the relational database. In addition, it also exercises the ability to drill up/down on the DR topology.
3. DRACS captures and stores behavior information on Demand Resources. This exercises updates of behavioral patterns to the relational database for each resource (or all resources connected at each meter, which is an acceptable roll up solution).
4. DRACS analyzes demand response scenarios. This exercises the following conditions:
   a. Database lookups of resources
   b. Database lookups of behavioral patterns
   c. Development of confidence level
5. User navigates Demand Resources topology. Users can access DRACS through a secure interface and review information on demand responsive resources, demand response events, proposed scenario analysis, and demand response events.

## 3.1 DRACS Monitors and Stores Real Time Network Information

DRACS will monitor, store, and provide visualization capabilities of the real time network information and related system events (weather, outages, voltage loss, etc.). The real time network monitoring capability allows system operators to view the DR network at any level, with the capability of zooming in or out along the network topology. This real time functionality is necessary in order to provide visual feedback of current relevant events superimposed on the DR topology. DRACS will interface to the EMS/SCADA and a weather feed.

DRACS is a "learning system", which means that the precision of system responses against DR events will become more accurate over time. This necessitates capturing the history of DR event activities. After each DR event, DRACS will capture and store pertinent information such as weather (temperature, precipitation, wind, etc.), time and duration of event, and system response characteristics. This information will be stored in the Demand Resource and Behavior Database and used by the Distributed Resource Analysis and Baseline Engine to provide more accurate DR system responses against DR requests over time.

### 3.1.1 Actors

| Actor | Type | Description |
|---|---|---|
| Distributed Resource Analysis And Control system (DRACS) | DRMS System Component | DRACS is a component within the Demand Response Management System (DRMS) responsible for the "situational awareness" of the real time network and Demand Resource topology. DRACS manages the database of Demand Resources, provides analysis of DR scenarios against DR events, and provides real time electrical network and Demand Resource visualization capabilities of the overall DR topology. The DRACS module includes a database of Demand Resources and their historical behavior against DR events, a baseline and scenario analysis component, and a real time network and DR topology visualization component. DRACS is responsible for analyzing requests for blocks of energy, capacity, reserves, or ancillary services and providing a predictive confidence level of success for meeting the requested Demand Resourceevent. DRACS uses measured responses to load demand requests to refine its internal model. |
| DRACS operator | Person | The DRACS operator monitors DR events and is the human-in-the-loop responsible for managing the situational awareness of the DR environment. |
| Energy Management System (EMS)/SCADA | System | Energy Management System/SCADA is used by operators of electric utility grids to monitor, control, and optimize the performance of the generation, transmission, and distribution system. |
| Weather Feed | System | The weather feed provides real time temperature, wind, and precipitation information. Photovoltaic measurements will also be captured, if available, in support of PV Demand Resource baselines and system response prediction calculations. |

### 3.1.2 Business Process and Sequencing

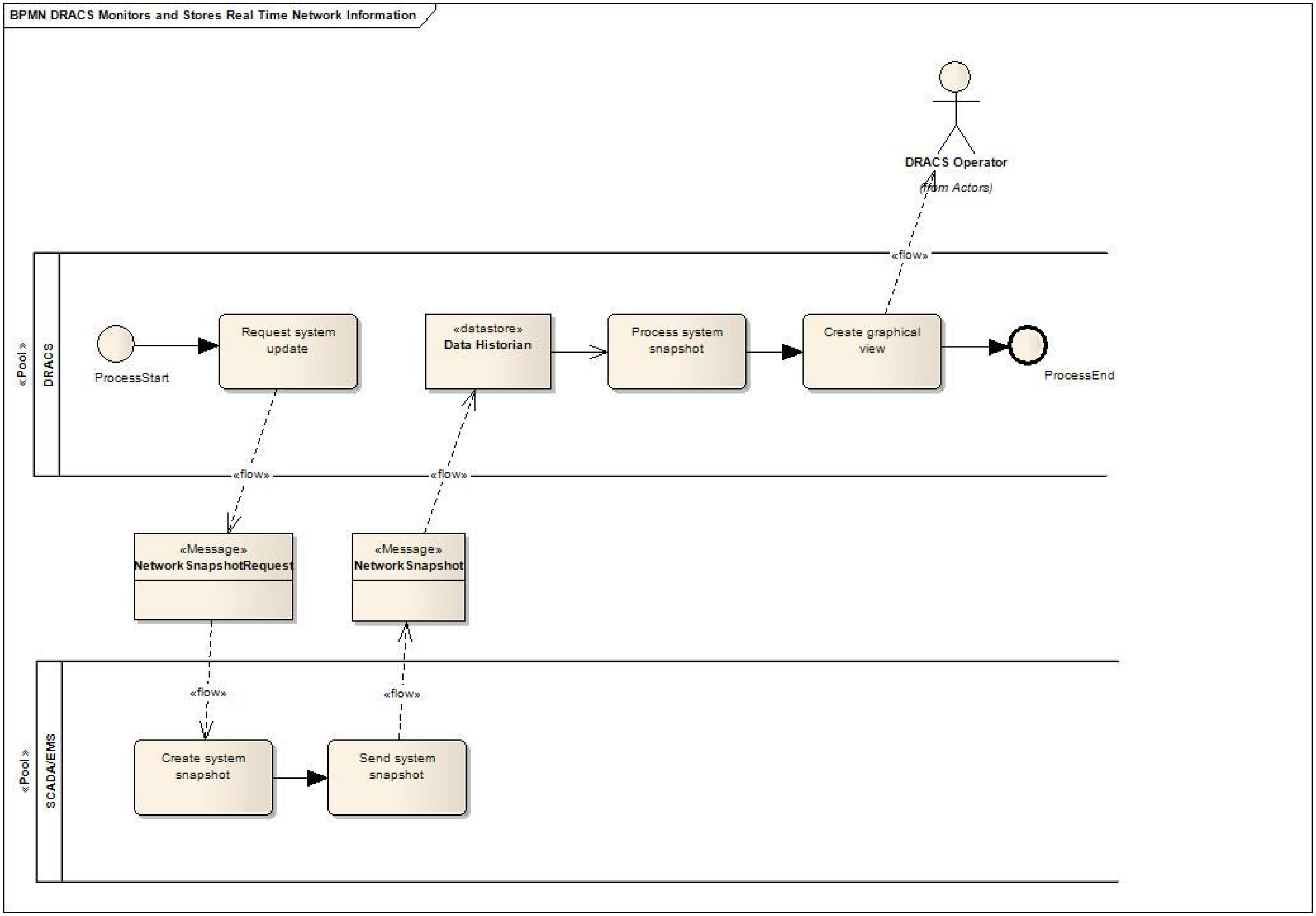


**Figure 3-1: Business Process Model – DRACS Monitors and Stores Real Time Network Information**

| **Step #** | **Actor** | **Description of the Step** | **Additional Notes** |
|---|---|---|---|
| *#* | *What actor, either primary or secondary is responsible for the activity in this step?* | *Describe the actions that take place in this step. The step should be described in active, present tense.* | *Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column..* |
| 1 | DRACS | DRACS requests from EMS/SCADA real-time snapshot of transmission and distribution system parameters and state | |
| 2 | EMS/SCADA | EMS/SCADA responds to request form DRACS and supplies real-time snapshot of transmission and distribution network topology and system parameters | The EMS/SCADA system has inherent delays in collecting and sharing system parameter data. This is due to a wide variety of issues, including communication latency, sensor limitations, collection rates, etc. The potential for chaotic behavior due to these latencies is not fully understood, but will require experimentation and study based on similar large harmonized real time systems, such as the C3I systems used by the Department of Defens |
| 3 | DRACS | DRACS stores real-time snapshot of transmission and distribution network topology and system parameters in local data historian | |
| 4 | DRACS | DRACS processes stored real-time snapshot of transmission and distribution network topology and system parameters | |
| 5 | DRACS Operator | DRACS Operator views Demand Resource geographical information | |

## 3.2 DRACS Manages Information on Demand Resources

Typically a utility or 3rd party aggregator will enroll customers into a Demand Reponse program. Each program will have characteristics and terms that the customer must comply with. Customers will enable DR equipment at their premise that will support this DR program. Each DR program may be optimized to deliver one particular type of Demand Resource service – Energy, Capacity, Reserve, or Regulation. A Demand Resource is added and removed and visualized on the DRACS system. This use case exercises the addition (provisioning) and removal (decommissioning) of Demand Resources from the Demand Resource and Behavior relational database.

### 3.2.1 Actors

| Actor | Type | Description |
|---|---|---|
| Distributed Resource Analysis And Control system (DRACS) | DRMS System Component | DRACS is a component within the Demand Response Management System (DRMS) responsible for the "situational awareness" of the real time network and Demand Resource topology. DRACS manages the database of Demand Resources, provides analysis of DR scenarios against DR events, and provides real time electrical network and Demand Resource visualization capabilities of the overall DR topology. The DRACS module includes a database of Demand Resources and their historical behavior against DR events, a baseline and scenario analysis component, and a real time network and DR topology visualization component. DRACS is responsible for analyzing requests for blocks of energy, capacity, reserves, or ancillary services and providing a predictive confidence level of success for meeting the requested DR event. DRACS uses measured responses to load demand requests to refine its internal model. |
| Demand Resource and Behavior Database | DRACS System Component | This relational database houses Demand Resource information such as the device type, service type, customer ID, path/topology information, enrolled customer programs, maximum load, normal load, GPS location, and any other attributes pertinent to understanding the location and load profile of the resource. In addition, the database also houses behavioral patterns of the resource based on historical response data. |
| Field Services | System | A service record will be created when provisioning or decommissioning a Demand Resource. |

### 3.2.2 Business Process and Sequencing

| Step # | Actor | Description of the Step | Additional Notes |
|---|---|---|---|
| *#* | *What actor, either primary or secondary is responsible for the activity in this step?* | *Describe the actions that take place in this step. The step should be described in active, present tense.* | *Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column..* |
| 1 | DRACS | DRACS adds/updates/removes Demand Resource in database. Demand Resource information to include DR program characteristics (type of Demand service capable of providing, daily operating parameters, season/annual parameters, etc.), customer profile (type of customer: residential, commercial, industrial, government, customer classification, etc.), and Demand Resource attributes (i.e. equipment type, load rating, max load reduction capability, etc.) | |
| 2 | DRACS | DRACS builds Demand Resource profile | |
| | | | |

## 3.3 DRACS Captures and Stores behavior information on Demand Resources

DRACS is responsible for capturing and storing historical behavior information on the Demand Resources. DRACS will interface with a Meter Data Management System (MDMS) or a Meter Billing System after DR events occur. Data will then be collected on participation and system response. This may be individual historical meter data, or if interval meter data is not available, then a sample data set that represents typical load characteristics for a customer class that the Demand Resource belongs to. With customer load profile data, DRACS will use this data to construct Demand Resource models for the Demand Resources in its Demand Resource and Behavior database. The behavior information is an important element in computing the confidence intervals (likelihood/probability) for meeting specific DR event requirements, and is the fundamental characteristic necessary to allow DRACS to "learn" and provide better and better accuracy over time.

Each Demand Resource (or customer) historical response to DR requests must be captured for use in predicting future behavior. DRACS will capture Demand Resource Service information for each event. Response to a DR Service event by individual Demand Resources will also be captured from the MDMS or sample recording of responses by typical customers in a class participating in the event. DRACS will then compute a baseline for each Demand Resource.

This information will be stored in a relational database and will be updated frequently to ensure optimal predictive information.

### 3.3.1 Actors

| Actor | Type | Description |
|---|---|---|
| Distributed Resource Analysis And Control system (DRACS) | DRMS System Component | DRACS is a component within the Demand Response Management System (DRMS) responsible for the "situational awareness" of the real time network and Demand Resource topology. DRACS manages the database of Demand Resources, provides analysis of DR scenarios against DR events, and provides real time electrical network and Demand Resource visualization capabilities of the overall DR topology. The DRACS module includes a database of Demand Resources and their historical behavior against DR events, a baseline and scenario analysis component, and a real time network and DR topology visualization component. DRACS is responsible for analyzing requests for blocks of energy, capacity, reserves, or ancillary services and providing a predictive confidence level of success for meeting the requested DR event. DRACS uses measured responses to load demand requests to refine its internal model.Demand Resource |
| Demand Resource and Behavior Database | DRACS System Component | This relational database houses Demand Resource information such as the device type, service type, customer ID, path/topology information, enrolled customer programs, maximum load, normal load, GPS location, and any other attributes pertinent to understanding the location and load profile of the resource. In addition, the database also houses behavioral patterns of the resource based on historical response data. |
| Meter Data Management System (MDMS) | System | System that gathers, validates, estimates and permits editing of meter data such as energy usage, generation, and meter logs. It stores this data for a limited amount of time before it goes to a data warehouse, and makes this data available to authorized systems. |
| Demand Response Management System (DRMS) | System | DRMS uses business rules to determine how to address DR event requests. Options include demand management (reduction or increase) through direct load control or demand management through pricing adjustments. DRMS is responsible for maintaining an estimate with a known precision of how much demand response resource is available for dispatch. DRMS is also responsible for accepting requests for blocks of energy and handling the details of implementing that request through the issuance of load control signals. DRMS is expected to track the "as implemented" response to load control signals to refine its internal model. |

### 3.3.2 Business Process and Sequencing

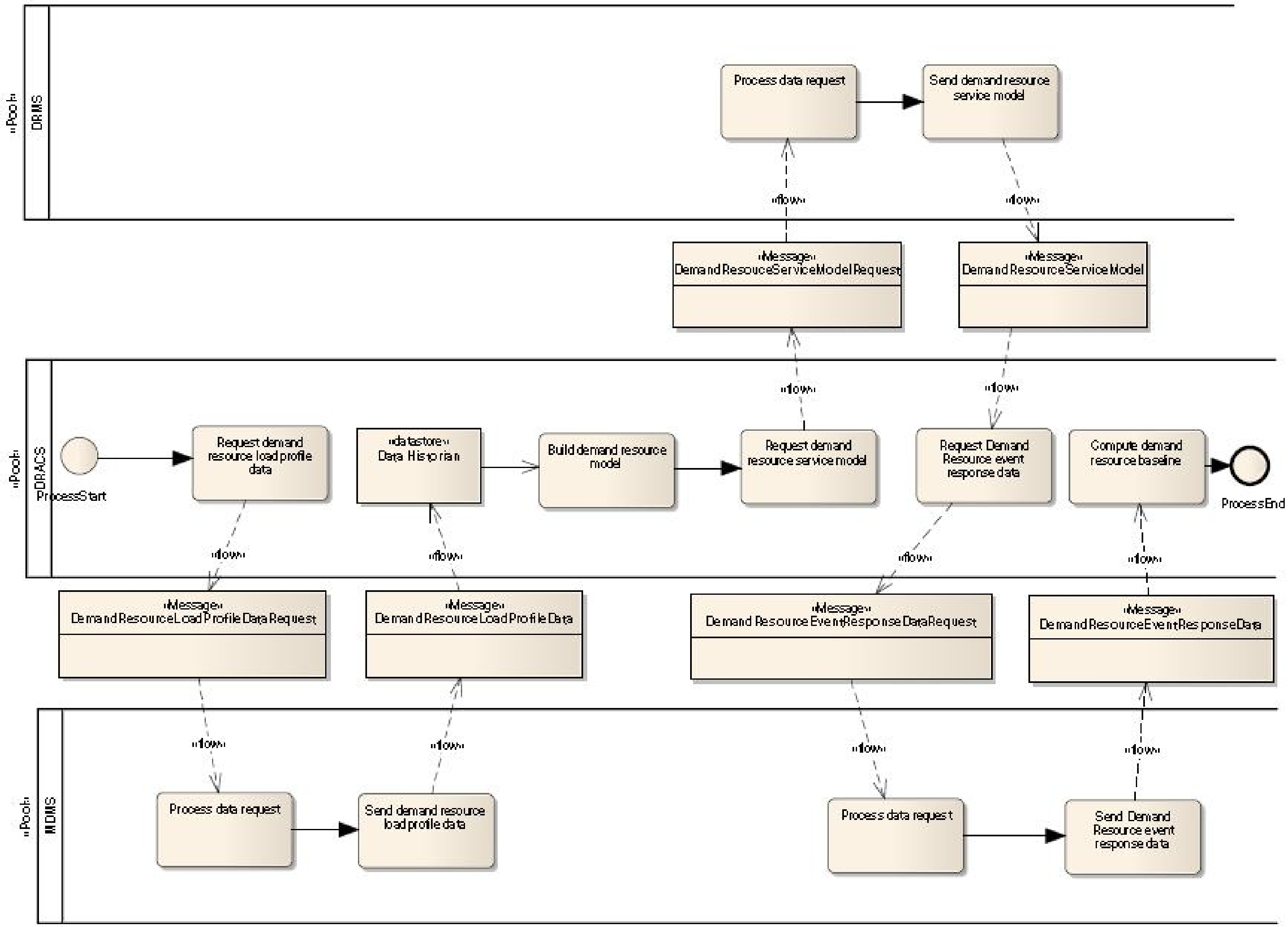


**Figure 3-2: DRACS Captures and Stores behavior information on Demand Resources**

| Step # | Actor | Description of the Step | Additional Notes |
|---|---|---|---|
| *#* | *What actor, either primary or secondary is responsible for the activity in this step?* | *Describe the actions that take place in this step. The step should be described in active, present tense.* | *Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column..* |
| 1 | DRACS | DRACS collects Demand Resource load profile data from MDMS or Meter Billing System | |
| 2 | MDMS | MDMS or Meter Billing System sends requested Demand Resource load profile datat to DRACS | |
| 3 | DRACS | DRACS builds Demand Resource model | |
| 4 | DRACS | DRACS requests Demand Resource service event information from DRMS. | |
| | DRMS | DRMS returns requested Demand Resource service event information to DRACS | |
| 5 | DRACS | DRACS collect Demand Resource event response data from MDMS all Demand Resources or from sample of representative Demand Resources | |
| 6 | MDMS | MDMS returns requested Demand Resource event response data to DRACS | |
| 7 | DRACS | DRACS computes baseline for Demand Resource | |
| | | | |

## 3.4 DRACS Analyzes Demand Response Scenario

DRACS receives “scenarios” from other modules within the DRMS system, which have been created based on the organization’s business rules. These scenarios provide a desired load response, the timeline involved, and a set of DR customers and resources. These scenarios are evaluated by the DRACS system to determine the likelihood (or confidence interval) of success in meeting the DR load response objective.

DRACS achieves this capability by employing standard network and historical pattern prediction algorithms and through analysis of customer behavior in responding to previous DR events.

### 3.4.1 Actors

| Actor | Type | Description |
|---|---|---|
| Distributed Resource Analysis And Control system (DRACS) | DRMS System Component | DRACS is a component within the Demand Response Management System (DRMS) responsible for the "situational awareness" of the real time network and Demand Resource topology. DRACS manages the database of Demand Resources, provides analysis of DR scenarios against DR events, and provides real time electrical network and Demand Resource visualization capabilities of the overall DR topology. The DRACS module includes a database of Demand Resources and their historical behavior against DR events, a baseline and scenario analysis component, and a real time network and DR topology visualization component. DRACS is responsible for analyzing requests for blocks of energy, capacity, reserves, or ancillary services and providing a predictive confidence level of success for meeting the requested DR event. DRACS uses measured responses to load demand requests to refine its internal model.Demand Resource |
| Demand Response Management System (DRMS) | System | DRMS uses business rules to determine how to address DR event requests. Options include demand management (reduction or increase) through direct load control or demand management through pricing adjustments. DRMS is responsible for maintaining an estimate with a known precision of how much demand response resource is available for dispatch. DRMS is also responsible for accepting requests for blocks of energy and handling the details of implementing that request through the issuance of load control signals. DRMS is expected to track the "as implemented" response to load control signals to refine its internal model. |

### 3.4.2 Business Process and Sequencing

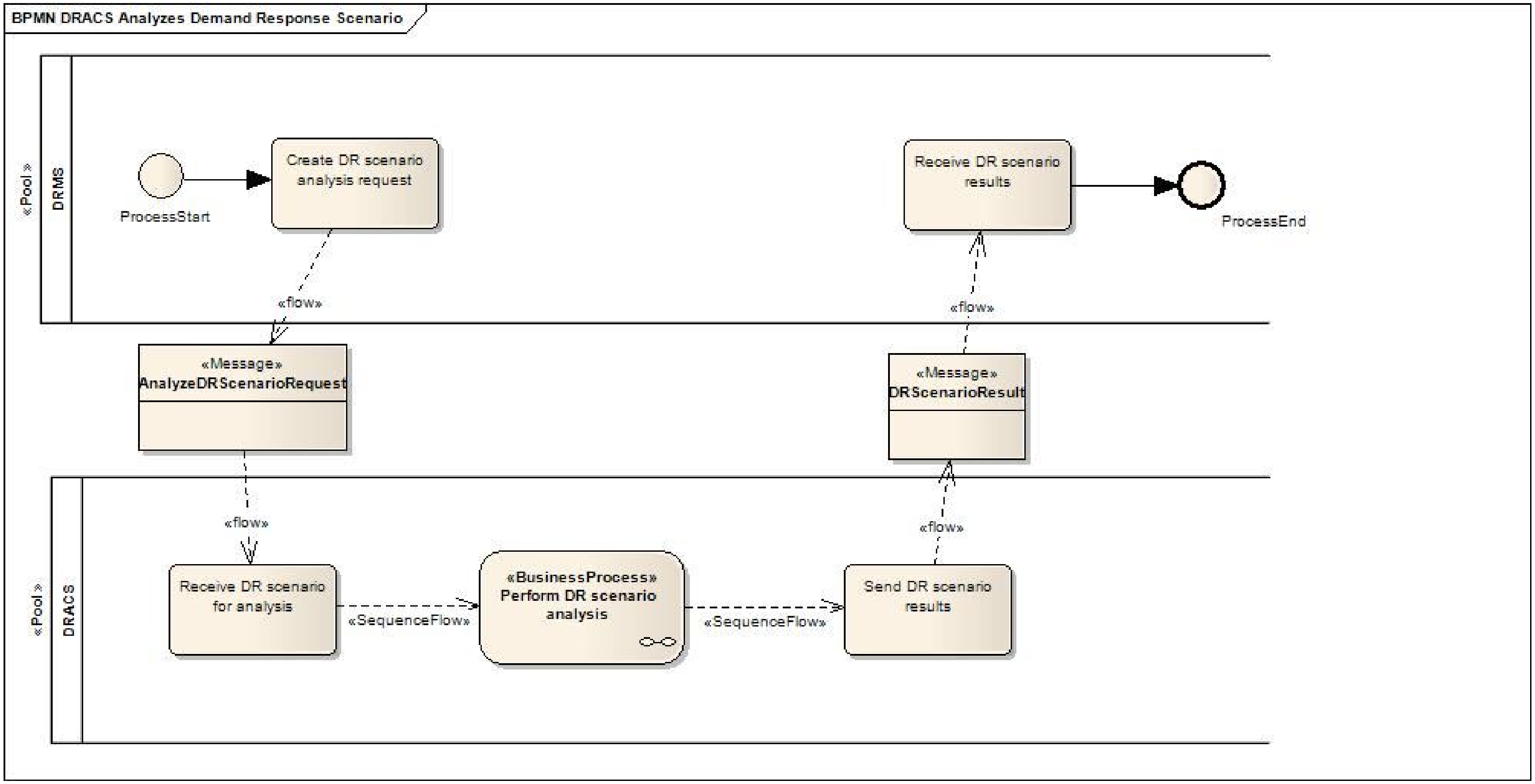


**Figure 3-3: DRACS Analyzes Demand Response Scenario**

| ***Step #*** | ***Actor*** | ***Description of the Step*** | ***Additional Notes*** |
|---|---|---|---|
| *#* | *What actor, either primary or secondary is responsible for the activity in this step?* | *Describe the actions that take place in this step. The step should be described in active, present tense.* | *Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column..* |
| 1 | DRMS | DRMS sends request to DRACS to analyze Demand Response scenario, includes Demand Response scenario paramaters. | |
| 2 | DRACS | DRACS process Demand Response scenario in Demand Response Analyzer / Simulator | |
| 3 | DRACS | DRACS posts results from Demand Response Analyzer / Simulator including projected Demand Response resource confidence level for requested Demand Response scenario | |
| 4 | DRMS | DRMS receives Demand Response scenario confidence level results from DRACS Analyzer/Simulator | |

## 3.5 User Navigates Demand Resources Topology

DRACS includes a “Google Map”-like visualization capability that allows the operator to drill up or down along the DR toplogy. Each Demand Resource has characteristics or “Properties” that are displayed alongside the map as they are selected by the operator. These properties include information such as the device type, service type, customer ID, path/topology information, enrolled customer programs, maximum load, normal load, GPS location, and any other attributes pertinent to understanding the location and load profile of the resource. Users can access DRACS visualization capabilities through a secure interface and review information on demand responsive resources, demand response events, proposed scenario analysis, and demand response events.

### 3.5.1 Actors

| Actor | Type | Description |
|---|---|---|
| Distributed Resource Analysis And Control system (DRACS) | DRMS System Component | DRACS is a component within the Demand Response Management System (DRMS) responsible for the "situational awareness" of the real time network and Demand Resource topology. DRACS manages the database of Demand Resources, provides analysis of DR scenarios against DR events, and provides real time electrical network and Demand Resource visualization capabilities of the overall DR topology. The DRACS module includes a database of Demand Resources and their historical behavior against DR events, a baseline and scenario analysis component, and a real time network and DR topology visualization component. DRACS is responsible for analyzing requests for blocks of energy, capacity, reserves, or ancillary services and providing a predictive confidence level of success for meeting the requested DR event. DRACS uses measured responses to load demand requests to refine its internal model. |
| DRACS client/operator | Interface | Client or User of DRACS that that is authorized to interface with DRACS through a secure interface |

### 3.5.2 Business Process and Sequencing

| Step # | Actor | Description of the Step | Additional Notes |
|---|---|---|---|
| *#* | *What actor, either primary or secondary is responsible for the activity in this step?* | *Describe the actions that take place in this step. The step should be described in active, present tense.* | *Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column..* |
| 1 | DRACS client/user | DRACS client/user views Demand Response resources on user interface screen | |

| Step # | Actor | Description of the Step | Additional Notes |
|---|---|---|---|
| 2 | DRACS | DRACS post requested DRACS information to requested view, including:<br>• Demand Response resource and baselines<br>• Proposed Demand Response scenario and analysis<br>• Demand response event, projected Demand Response resource available, and Demand Response event results | |
| | | | |

# 4. Requirements

## 4.1 Functional Requirements

| Functional Requirements | Associated Use Case (if applicable) | Associated Step # (if applicable) |
|---|---|---|
| FR1 - DRACS shall be capable of requesting real-time snapshots of the transmission and distribution network events and system parameters from EMS/SCADA. This data request includes pertinent network events (outages, voltage drops/loss, equipement status, etc.) and the load profile for the network location(s) being evaluated. | 3.1 | 1 |
| FR2 - DRACS shall be capable of requesting current weather data | 3.1 | 1 |
| FR3 - DRACS shall be capable of storing real-time snapshot of transmission and distribution network events and system parameters in lDemand Resource and Behavior database. At a minimum, these event snapshots will be collected at the beginning and the completion of each DR event. | 3.1 | 3 |
| FR4 - DRACS shall be capable of providing geographic visualization of system parameters and the electrical network topology to include Demand Resources | 3.1 | 4 |
| FR5 - DRACS Operator shall be capable of viewing Demand Resource geographical information | 3.1 | 5 |
| FR6 - DRACS shall be capable of adding/updating/replacing/deleting Demand Resources in the Demand Resource and Behavior database. Stored Demand Resource information shall include enrolled DR programs , (type of Demand Resource service capable of providing, daily operating parameters, season/annual parameters, etc.), customer profile (type of customer: residential, commercial, industrial, government, customer classification, etc.), and Demand Resource attributes (i.e. equipment type, load rating, max load reduction capability, etc.) | 3.2 | 1 |
| FR7 - DRACS shall be capable of building and maintaining Demand Resource profiles | 3.2 | 2 |
| FR8 - DRACS shall be capable of collecting Demand Resource load profile data from MDMS or Meter Billing System | 3.3 | 1 |
| FR9 - DRACS shall be capable of building Demand Resource profile | 3.3 | 3 |

| Functional Requirements | Associated Use Case (if applicable) | Associated Step # (if applicable) |
|---|---|---|
| FR10 - DRACS shall be capable of collecting Demand Resource service event information from DRMS. | 3.3 | 4 |
| FR11 - DRACS shall be capable of collecting DR event behavior responses for each Demand Resource or customer from MDMS, CIS, or from statistical sampling of representative Demand Resources. DRACS shall store this data in the Demand Resource and Behavior database. | 3.3 | 6 |
| FR12 - DRACS shall be capable of computing the three types of Baselines (Baseline 1 – interval metered, Baseline 2 – non-interval metered, Behind the Meter) for Demand Resources | 3.3 | 8 |
| FR13 - DRACS shall be capable of utilizing historic Demand Resource service event behavior data from the Demand Resource and Behavior database. | 3.3 | 8 |
| FR14 - DRACS shall be capable of evaluating the likelihood of success for Demand Response scenarios, which are passed to it by other modules within the DRMS | 3.4 | 2 |
| FR15 - DRACS shall be capable of returning results from Demand Response Analyzer/Simulator including projected Demand Response resource confidence level for requested Demand Response scenario | 3.4 | 3 |
| FR16 - DRACS client/operator shall be capable of viewing Demand Resources individually and as an aggregation of multiple Demand Resources on user interface screen. DRACS shall provide Demand Resource topology views geographically (on a map) and display the properties of the selected Demand Resource or aggregation of multiple Demand Resources. | 3.5 | 1 |
| FR17 - DRACS shall be capable of providing requested DRACS information to requested view, including:<br>• Demand Resource and Baselines<br>• Proposed Demand Response scenario and analysis<br>• Demand response event, projected Demand Response resource available, and Demand Response event results | 3.5 | 2 |
| | | |

## 4.2 Business and Non-Functional Requirements

| Business Requirement | Associated Scenario # (if applicable) | Associated Step # (if applicable) |
|---|---|---|
| BR1 - Client or User interfaces to DRACS through a secure method. Access will be controlled with usernames and passwords from the Lightweight Directory Access Protocol (LDAP) system of record. | 3.5 | 1,2 |
| BR2 – DRACS system will comply with IEC 61968 (System interfaces for distribution management) and IEC 61970 (Energy management system application program interface) interoperability standards | | |
| BR3 – DRACS system will comply with North America Energy Standards Board (NAESB) Demand Side Management and Energy Efficiency (DSM-EE) standards | | |
| BR4 – DRACS system will comply with NERC Demand Response standards | | |
| BR5 – Behavioral data from Demand Resources shall be refreshed in the Demand Resource and Behavior database at least once daily | | |
| BR6 – DRACS shall check to ensure Demand Resources entered in the Demand Resource and Behavior database are still active every 30 days | | |
| BR7 – DRACS shall support web services interfaces for common database inquiries. This will reduce direct access to the Demand Resource and Behavior database by other systems/applications. Other systems/applications needing access will use the web service abstraction layer to get data. | | |
| BR8 – DRACS shall provide web services interfaces for scenario evaluation requests and support a Service Oriented Architecture (SOA). | | |
| BR9 – DRACS shall include an automated import mechanism (as a web service) to add and remove Demand Resources from the Demand Resource and Behavior database. | | |
| BR10 – It is anticipated that the Demand Resource implementation will grow over time and will become commonplace and pervasive as Home Area Network (HAN) technologies mature. The Demand Resource and Behavior database shall be scalable to support and manage 10's of millions or even 100's of millions records. | | |
| BR11 – DRACS shall include an event auditing function that will capture the event, time, event | | |

| Business Requirement | Associated Scenario # (if applicable) | Associated Step # (if applicable) |
|---|---|---|
| type, event results, and operator or system who intiated the event | | |
| BR12 – DRACS shall include an error log capturing the error, time, error type, and error results | | |
| BR13 – DRACS visualization shall color-code Demand Resources to indicate whether they are load reduction, load generation, or both. | | |
| BR14 – Demand Resources shall be categorized by geographic location, circuit location, aggregation points, Demand Resource service type, and enrolled Demand Response programs, | | |
| BR15 – The Distributed Resource and Baseline Engine shall include algorithms to predict system response, network latencies, and potential chaotic response behavior from a large number of Demand Resources (overshooting load objectives). | | |
| BR16 – Only administrator users will have access to administrative functions, average users will not. | | |
| BR17 – It is anticipated that the Demand Resource implementation will grow over time and will become commonplace and pervasive as Home Area Network (HAN) technologies mature. The DRACS system shall be scalable to support and manage 10's of millions or even 100's of millions of Demand Resources. | | |
| BR18 – System will not require vendor for standard maintenance. For extraordinary maintenance or upgrades, system vendor will be available. | | |
| BR19 – DRACS system is mission-critical. Reliability and uptime are important design criteria. Uptime will be 99.8%. | | |
| | | |

# 5. Glossary

| Glossary | |
|---|---|
| **Term** | **Definition** |
| Baseline | A Baseline is a method of estimating the electricity that would have been consumed by a Demand Resource in the absence of a Demand Response Event. The Baseline is compared to the actual metered electricity consumption during the Demand Response Event to determine the Demand Reduction Value. Depending on the type of Demand Response product or service, Baseline calculations may be performed in real-time or after-the-fact. |
| Capacity Service | A type of Demand Response service in which Demand Resources are obligated over a defined period of time to be available to provide Demand Response upon deployment by the System Operator. |
| Demand Resource | A Load or aggregation of Loads capable of measurably and verifiably providing Demand Response. |
| Deman Resource Service | Demand Resources can support four (4) different types of services; Energy, Reserve, Capacity, or Regulation service |
| Demand Response | A temporary change in electricity consumption by a Demand Resource in response to market or reliability conditions. For purposes of this requirements document, Demand Response does not include energy efficiency or permanent Load reduction. |
| Energy Service | A type of Demand Response service in which Demand Resources are compensated based solely on Demand reduction performance. |
| Regulation Service | A type of Demand Response service in which a Demand Resource increases and decreases Load in response to real-time signals from the System Operator. Demand Resources providing Regulation Service are subject to dispatch continuously during a commitment period. Provision of Regulation Service does not correlate to Demand Response Event timelines, deadlines and durations. |
| Reserve Service | A type of Demand Response service in which Demand Resources are obligated to be available to provide Demand reduction upon deployment by the System Operator, based on reserve capacity requirements that are established to meet applicable reliability standards. |
| System Operator | A System Operator is a Balancing Authority, Transmission Operator, or Reliability Coordinator whose responsibility is to monitor and control an electric system in real time (based on NERC definition). The System Operator is responsible for initiating Advance Notifications, Deployment, and Release/Recall instructions. |

# 6. References

NAESB Wholesale DR Measurement and Verification Standards, December 2008.