Requirements Engineering for the Advance Metering Infrastructure and the Home Automation Network (AMI-HAN) Interface

Final Report

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Abstract

The main goal of this research project was to identify policy guidelines for the interface between California investor-owned utilities (IOU's) Advanced Metering Infrastructure (AMI) and California residential electricity customers and their equipment that will promote the success of demand response (DR), a critical component of California's Energy Action Plan II. A secondary goal was to perform the research using requirements engineering techniques and evaluate how useful the techniques are for defining policy guidelines.

A project team using requirements engineering techniques, analyzed documents produced by the utility industry group, UtilityAMI, which described the utility AMI interface to customers home automation network equipment. This analysis included modeling with context diagrams, Venn diagrams and use case scenarios. A second set of models representing an open market configuration was created for comparison. From this process rights and obligations of customers, vendor and utilities were identified and validated.

The final recommendation of this report is the adoption of the rights and obligations defined in this report as a primary requirement for governing California IOU's proposals for their AMI system and DR rates and programs. It is also recommended that the requirements engineering process used in this project, should be utilized in projects focused on developing policy.

Keywords: Advanced Metering Infrastructure, AMI, Demand Response, home automation network, HAN, obligations, OpenHAN, policy, requirements engineering, rights, use cases, utility, UtilityAMI

Executive Summary

Introduction

The state of California has identified demand response (DR) as a critical component of the state Energy Action Plan II, and the Advance Metering Infrastructure (AMI) as an essential technology for customer participation in DR and related dynamic pricing initiatives. In response to subsequent AMI and DR related rulings and legislation, California investor-owned utilities (IOU's) are investing significant resources to develop their AMI systems and define their DR rates and incentive programs. To this end the California IOU's have participated in UtilityAMI, a consortium of utilities and vendors, who have developed generic use cases and supporting documents to define the interface between the utility AMI and the customer's equipment, which they have called OpenHAN. It includes control devices such as programmable communicating thermostats (PCT), display devices, home automation systems and home area networks (HAN) which are clearly on the customer side of this interface. How the utility AMI system and the customer's equipment are integrated will play a significant role in determining the success of the Energy Action Plan II and to what degree the customer is provided with and responds to pricing and DR options.

Purpose

The goal of this project was to develop policy guidelines that would foster the greatest customer participation in DR by examining the regulatory, technology, and customer choice implications of various the AMI-customer equipment interface configurations.

Project Objectives

The main research objective of this project was to develop policy guidelines for the interface between the utility AMI system and the customer's equipment including but not limited to Title 24 PCT and HAN. To accomplish this, the project team was tasked with examining existing relevant documentation vetted by the California IOU's and modeling various AMI-customer equipment configuration scenarios to answer the following questions:

- What is needed in the AMI customer equipment interface to promote wide-spread and effective customer participation in DR?

- Do utility proposed AMI customer equipment solutions comply with current and upcoming DR-related direction by the state of California?

- Are there any responsibility and ownership issues in the AMI customer equipment interface that might threaten an open competitive HAN market or compromise customer choice?

The other research objective was to use a collaborative requirements engineering process and evaluate how successful this approach is in identifying policy guidelines.

Project Outcomes

A team of California Energy Commission staff and consultants lead by a requirements engineer at L'Monte Information Services, developed requirements models to examine the implications of various AMI-customer configuration scenarios. This included analysis and modeling of UtiltyAMI's OpenHAN Task Force documentation. The resulting models represented two different customer options: the configuration defined in the OpenHAN documentation, called the utility programs option and a configuration which separates the utility and customer domains and is not defined and controlled by the utility, called the open market option. From these models the team identified policy guidelines in the form of customer, vendor and utility rights and obligations that should be provided for in the utility AMI systems and DR offerings.

The project team used a requirements engineering process of combining graphical modeling such as context and Venn diagrams with text-based techniques such as use case scenarios to evaluate different configurations of the AMI customer equipment interface. Using different models gave the project team multiple vantages points for evaluation. For example, the rights and obligations generated with the graphical models were validated through the development of use case scenarios.

Conclusions

To foster the most effective development of pricing, DR, and other energy programs, utility AMI systems must provide the customer with the open market option as well as the utility programs option. The four main rights defined in this report are the following:

R1. Customers have the right to receive price (periodic and real-time) signals and reliability signals without enrolling in utility programs and without registering their equipment with the utility.

R2. Customers have the right to purchase, rent or otherwise select from any vendor any and all devices and services used in their premise.

R3. Vendors have the right to compete in an open market to sell HAN systems, devices and services to all utility customers.

R4: Utilities have the right to offer DR and energy management services to customers which utilize the informational and communication capabilities of their AMI system.

The requirements engineering techniques used were effective in analyzing and evaluating the AMI customer equipment interface being researched in this project. The project team found the process of developing multiple graphical and textual models and extracting and validating rights and obligations provided a consistent method for expressing policy guidelines.

Recommendations

As a result of these findings, it is recommended that the rights and obligations defined in this report be used as a primary policy guideline for governing all California IOU proposals for their AMI system and DR rates and programs. It is also recommended that the California IOU's should demonstrate through use case scenarios or other requirements representation, how they will provide the open market option to support the customer and vendor rights defined in this report.

It is recommended that projects focused on defining policy guidelines should consider utilizing this requirements engineering process of modeling the information and extracting rights and obligations from the models to form policy guidelines.

Benefits to California

DR, a critical component of the California's Energy Action Plan II, has the potential to increase reliability of the California's electric grid and avoid the expense of building new generation capacity to meet peak demand. The success of DR depends to a large extent on how the utilities implement their Advance Metering Infrastructure systems. The rights and obligations in the AMI customer equipment interface recommended as policy guidelines in this report, if adopted will ensure that California IOU's include in their AMI configuration and DR offerings more opportunities for customers to participate in DR. It is envisioned that increasing customer opportunities to participate in DR will result in more effective DR in California.

1.0 Introduction

The state of California has identified energy efficiency (EE) and demand response (DR) as top priorities for addressing increasing energy needs in California. The effectiveness of DR is closely linked to Advance Metering Infrastructure (AMI), an essential technology for customer participation in DR.

In response to AMI and DR related rulings and legislation, California investor-owned utilities (IOU's) are investing significant resources to develop their AMI systems and define their DR rates and incentive programs. To this end the CA IOU's have participated in the UtiltyAMI, a consortium of utilities and vendors who have developed generic use cases and supporting documents for defining the interface between the utility AMI and the customer's home automation network (HAN). The OpenHAN as it is called includes control devices such as PCT's, display devices and HAN's which are on the customer side of the interface. At the same time there has been rapid growth in the HAN market segment with vendors offering new products that are also on the customer side of the interface. How these two systems, the utility AMI system and the customer's equipment including HAN systems, are integrated will play a significant role in customer DR performance.

The Public Interest Energy Research (PIER) Energy Systems Integration (ESI) program funded this research to evaluate the utility AMI customer equipment interface and derive recommendations and policy guidelines that would promote and expand the customer's ability to perform DR.

A second key objective of this project was to evaluate the effectiveness of using a collaborative requirements engineering approach to perform this research. In particular, JAD workshops and requirements modeling including use cases were defined as part of the requirements engineering approach.

2.0 Project Approach

A project team of California Energy Commission staff and consultants working in the DR field, led by a requirements engineer, was formed to develop requirements models including a project charter, context diagram and use case scenarios of the utility AMI customer equipment interface. The modeling sessions were originally planned to be facilitated joint application development (JAD) workshops. A JAD workshop is a facilitated collaborative session with specific deliverables. Usually there is a series of JAD workshops with the same group of participants who perform requirements exercises to produce the workshop deliverables.

The first JAD workshop was held to create a project charter. The resulting project charter which can be found in Appendix A indentified the project stakeholders, critical success factors and critical risks and issues. This document was used to guide the project through to the production of this final report.

The original plan was to develop all the requirements models using facilitated JAD workshops with a project team. However, due to constraints on team member availability and lack of time for requirements engineering training, the process adopted was for the requirements engineer

to create draft models which were presented at review and editing sessions with the project team.

3.0 Project Outcomes

An analysis of OpenHAN use case documentation which was approved by the California IOU's, was undertaken to evaluate its definition of the AMI customer equipment interface. After reading the use cases available at the time, the document, *Joint IOU HAN Use Case Definitions / Assumptions / Actors*, hereafter referred to as the *OpenHAN document*, was selected for detailed analysis. This document was selected because it was referred to throughout the OpenHAN use cases and foundational to all other OpenHAN documentation, and it appeared to be complete, unlike most of the use cases at the time. In a presentation toward the end of the project, a member of the UtilityAMI OpenHAN taskforce explained that this document did not represent all of the concepts later developed in some of the OpenHAN material. Therefore the project team recognizes that the *OpenHAN document* did not cover all of the configurations developed by the OpenHAN Task Force. However, the *OpenHAN document* does represent the scenario that the utilities have been most focused on which is customers who enroll in a utility DR program.

Modeling the OpenHAN configuration using Venn diagrams and context diagrams, showed a configuration consisting of a two-way AMI communication system to the customer equipment with the requirements that the customer register their equipment with the utility and the customer enroll in a utility program. The OpenHAN configuration is therefore called the utility programs option.

A second set of matching models were created depicting a one-way broadcast communication that clearly separated the utility domain from the customer domain and allowed for more customer choice and customer autonomy. This is called the open market option.

3.1. Analysis of the *OpenHAN document*

Analysis of the *OpenHAN document* showed that only the utility programs option was defined.

There are a number of assumptions and definitions in this document that appear to be in conflict with the open market option. The following two assumptions are the clearest examples of such conflicts,

> "Customers must be enrolled in a demand response program to enable communications between the utility and the customer's control devices"[1]
>
> "All communications between the Utility AMI network and the HAN Devices are passed through the AMI Network Gateway"[2]

In these assumptions and others the defined configuration requires that the customer enroll in utility programs in order to access to price and reliability signal, and that all communication to the customer's HAN devices must go through the AMI communication system.

Another concern is the actor called the Utility HAN, which is defined as the controlling agent for all customer demand response. In particular, devices that do not use the AMI communication protocol are labeled "non-interoperable" and cannot participate in utility rates or programs. This configuration restricts customer choice of devices and services. It also restricts vendors by applying unfair control over the open market of energy control and energy management devices and services, and HAN related devices and services. A more flexible configuration would allow for a translation device provided by the customer for communication between the AMI system and any "non-interoperable" devices. This configuration would also guarantee that the AMI system communication protocol is an open protocol based on industry standards.

3.2. Requirements Modeling of the Open Market and Utility Programs Options

To understand the differences and implications of the open market option and the utility programs option, the project team developed both graphical and textual models. Venn diagrams were developed to explore how the system boundaries are different in the two options. Context diagrams were developed to explore how the interfaces between all systems and actors are different in the two options. Graphical scenarios provided a more concrete representation of the two options. Use case scenarios were created to explore the interactions between the customer, their equipment and the utility AMI in order to understand and validate the rights and obligations which had been defined with previous models.

3.2.1. Venn Diagrams

Figure 1 depicts the open market option with broadcast price and reliability signals. There is a clear separation between the utility AMI system and the customer's equipment including any HAN with its attached devices. The price & reliability signals are broadcast and do not travel through the AMI- customer equipment interface. They are available to any devices in the customer premise that can receive the broadcast signal. This open market option allows customers to participate in demand response, regardless of the equipment and services they have chosen and allows vendors to provide devices and services in a market that is not controlled by utility prescribed technologies.

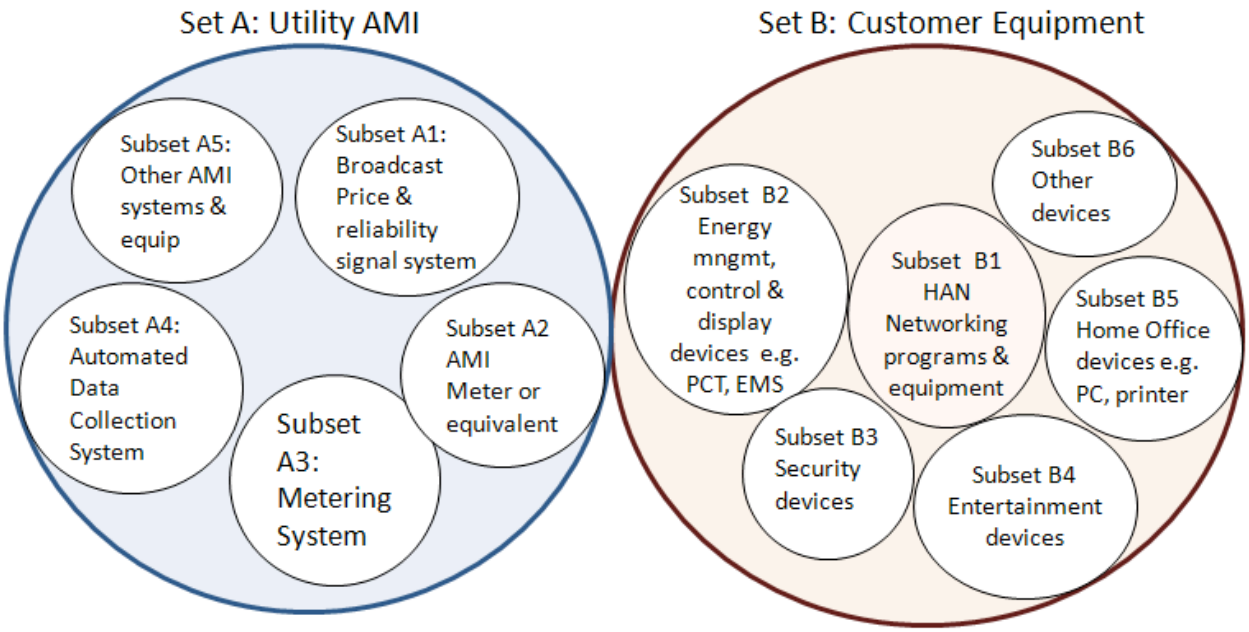

Figure 1. Venn Diagram 1: Open Market Option with Broadcast Price & Reliability Signals

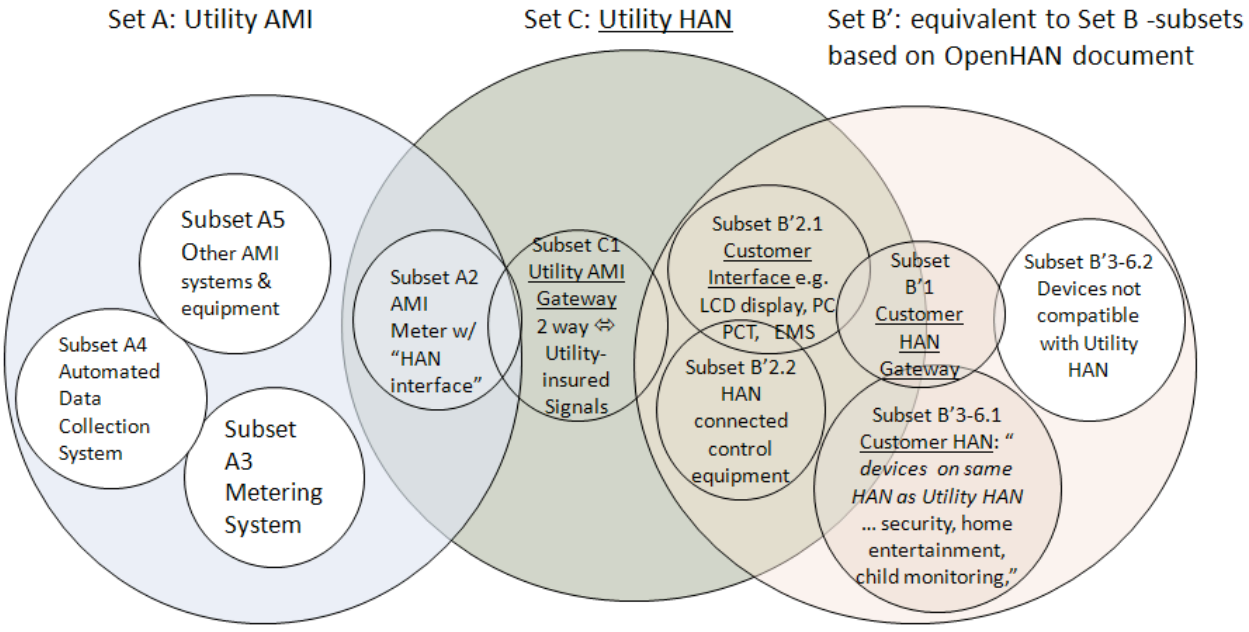

Figure 2. Venn Diagram 2: Utility Programs Option with Utility Price & Reliability Signals

Figure 2 depicts the more complex utility programs option as it is defined by the actor descriptions, definitions and assumptions in the *OpenHAN document*. The Utility HAN actor is a new set containing the Utility AMI Gateway through which all price and reliability signals are delivered, making it the controlling agent for all the customer demand response activity. The Utility HAN is also described as containing all energy control devices, all interface devices and an actor called the Customer HAN, (Subset B'3-6.1) which contains all non-energy devices on the HAN that use the AMI communication protocol. There is no mention of broadcasting price & reliability signals in the *OpenHAN document* and therefore Set A does not have a subset A1.

All devices in the customer's premise that do not use the AMI communication protocol are in subset B'3-6.2. These devices cannot participate in utility rates or programs and therefore cannot receive the price & reliability signals sent through the utility's AMI system.

3.2.2. Context Diagrams

The context diagram in Figure 3 depicts the open market option. There is a simple interface between the Utility AMI and the customer equipment. The vendors have a direct interface with the equipment and services the customer has selected from them. The price & reliability signals are broadcast and can be picked up by any device that has the ability to receive the broadcast signals.

The context diagram in Figure 4 depicts the utility programs option defined in the OpenHAN document. The single interface is replaced with a new system made up of the Utility HAN and Customer HAN. Customer networks and equipment that are "non-interoperable" because they use a different communications protocol than the AMI system, are in a separate system which cannot participate in utility programs or rates.

In this configuration, vendors of energy management system (EMS) equipment and EMS services can only interface with the Utility HAN and therefore must use the utility defined communications protocol. Other vendors have two dotted line interfaces indicating that their interface depends on if they are interoperable with the utility AMI. If they are, then the interface is to the Utility HAN + Customer HAN system. If their product is non-interoperable, the interface is to the other network system and they will not receive a signal.

The following context diagrams use traditional and special symbols as defined in Table 1.

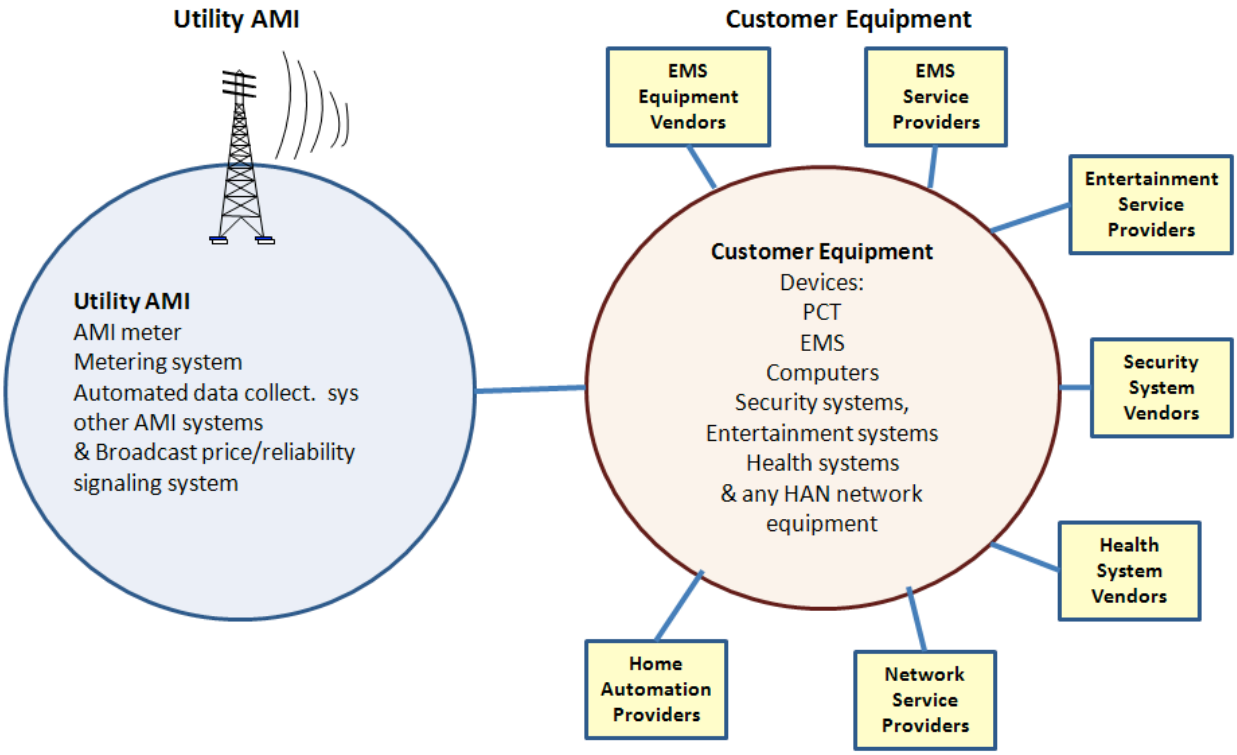

Figure 3. Context Diagram 1: Open Market Option with Broadcast Price & Reliability Signals

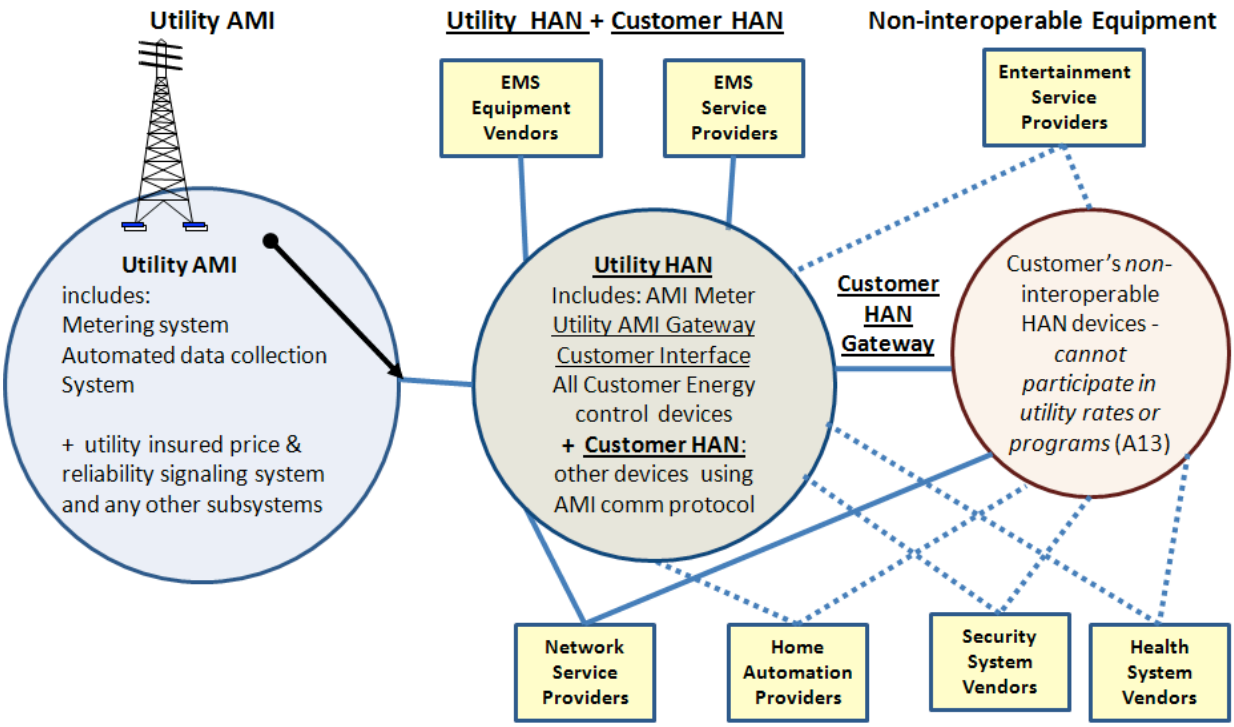

Figure 4. Context Diagram 2: Utility Programs Option with Utility Price/Reliability Signals

SYMBOL	DESCRIPTION
	A system and all of its subsystems
	An actor with a relationship to a system; may be human, equipment, or software programs
	Interface between two systems or an actor and a system
	Interface with several possible connections
	Utility AMI price/reliability signals
	Broadcast one-way price/reliability signals
	Original source of price/reliability signals

Table 1. Context Diagram Symbol Legend

3.2.3. Graphical Scenarios

Graphical scenarios are line drawing representations of the physical arrangements. They provide a more concrete view of the two options and were used to corroborate the more abstract context diagrams and Venn diagrams.

Figure 5 depicts the open market option for a customer who has one or more individual devices that can receive broadcast price & reliability signals and be programmed to respond. The devices are not required to register with the utility and do not send information to the utility AMI system. A customer premise with just a Title 24 PCT using the built-in RDS communication system is a specific example of this scenario.

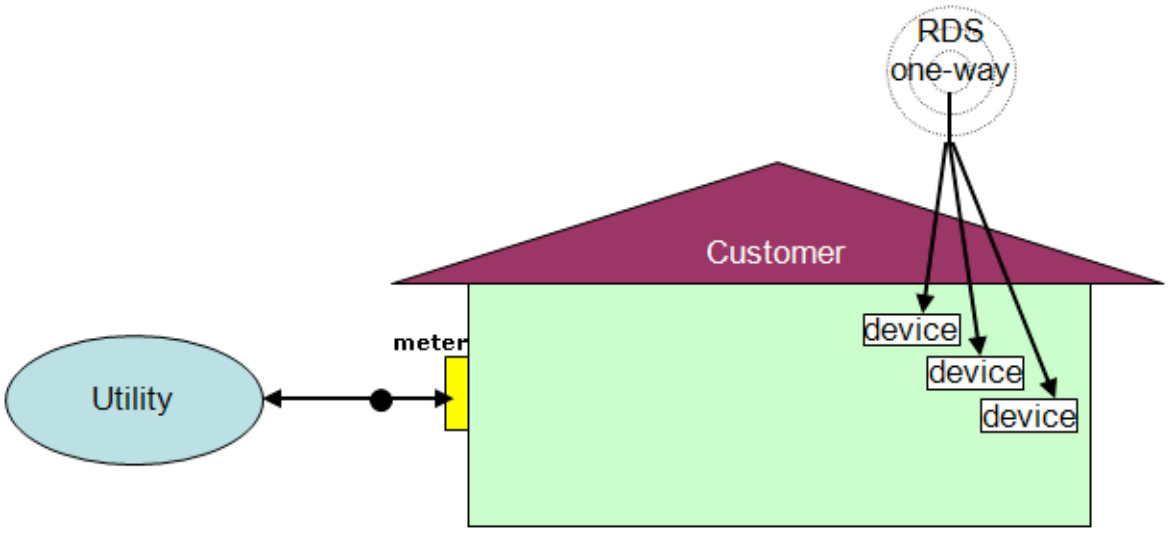

Figure 5. Graphical Scenario 1: Open Market Option – Individual Devices

Figure 6 depicts the open market option for a customer who has devices attached to a controlling device such as a PCT or to a HAN. In this sketch the broadcast signal is received by the controlling device and then passed on to the attached devices. Again there is no registration or communication to the utility AMI system.

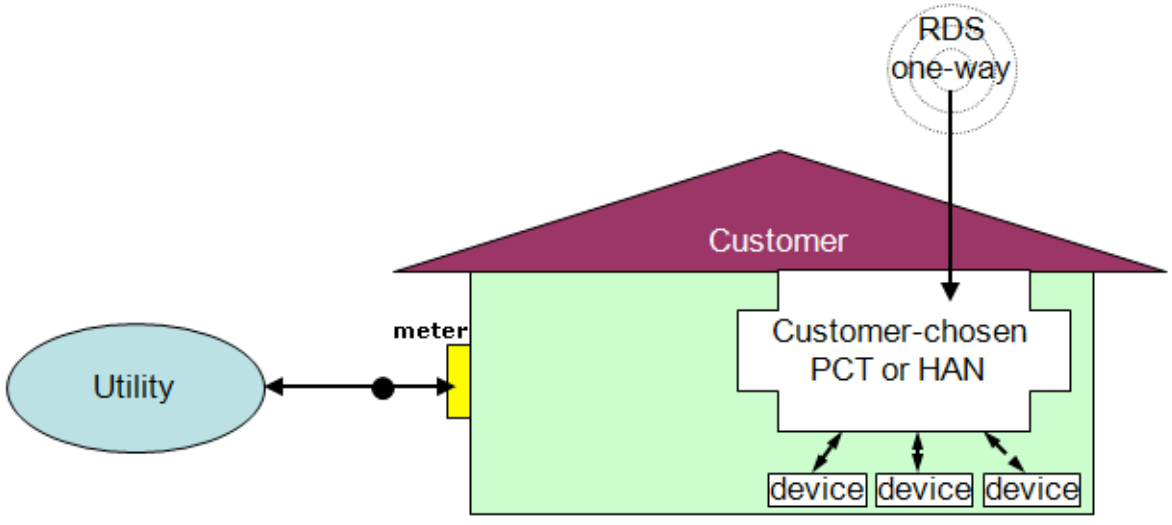

Figure 6. Graphical Scenario 2: Open Market Option – PCT or HAN Plus Attached Devices

The utility programs option depicted in Figure 7 provides two-way communication for customer devices that are interoperable with the utility AMI. Using the two-way communications through the Utility AMI gateway, the devices register with the AMI system, receive utility price and reliability signals and return information required by the utility AMI system. This sketch shows one device that does not receive the signal because it does not use the utility defined communications protocol and is considered non-interoperable.

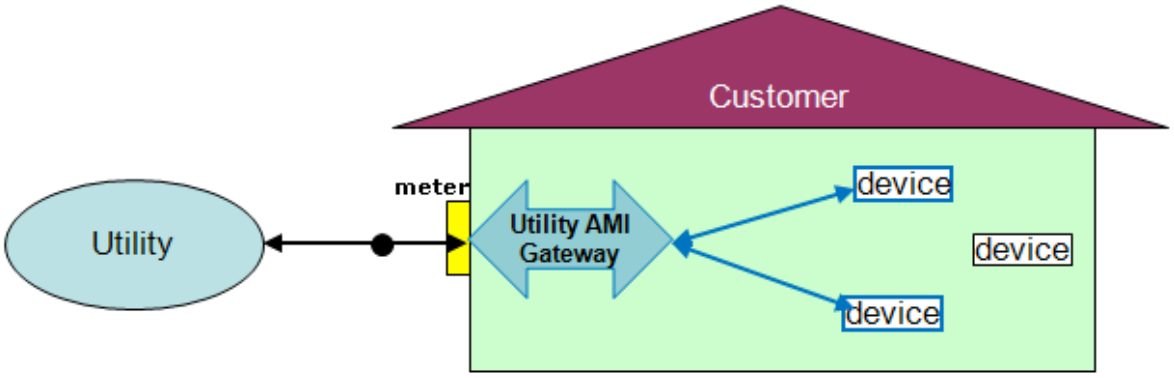

Figure 7. Graphical Scenario 3: Utility Programs Option – Individual Devices

The graphical scenario in Figure 8 depicts the utility programs option for a customer who has devices attached to a controlling device such as a PCT or to a HAN. As with Figure 7, two-way communication through the utility AMI gateway allows the HAN or PCT to register itself with the AMI system, receive utility price and reliability signals and return information required by the utility AMI system. This sketch shows one device that does not receive the signal because it does not use the utility defined communications protocol and is considered non-interoperable

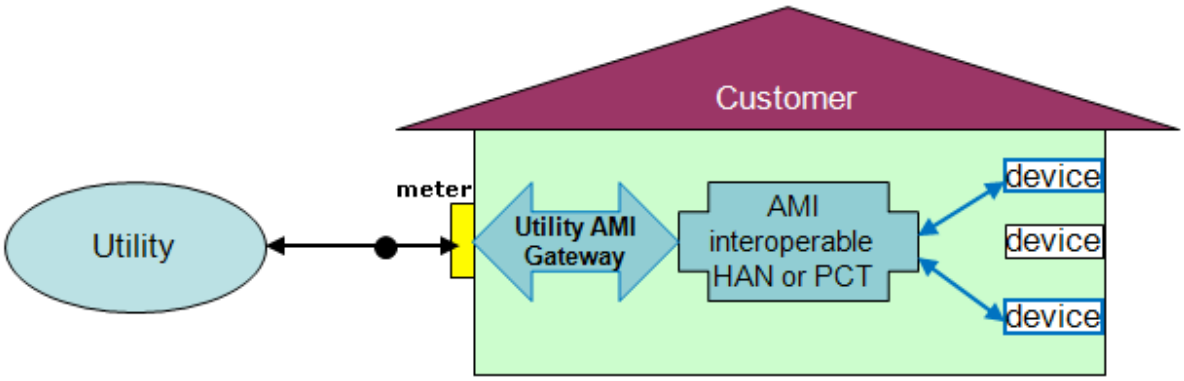

Figure 8. Graphical Scenario 4: Utility Programs Option – PCT or HAN Plus Attached Devices

3.2.4. Use Case Scenarios

Use case scenarios describe the interactions between a system & an actor to satisfy the actor's goal. Alistair Cockburn in his book *Writing Effective Use Cases*, explains that a use case captures a contract between the stakeholders of a system about its behavior. As such, use case scenarios are useful for exploring the validity of system and actor rights and obligations identified using other requirements models.

In the use case scenarios developed for this project, the system is the California investor-owned utility & their systems, and the primary actor is a California residential electricity customer. Two sets of use case scenarios were developed, one for the open market option and one for the utility programs option. The objective was to explore the validity of customers and utility rights and obligations already defined, and reveal any new rights and obligations in the interaction. In this exercise of envisioning an interaction that does not exist yet, functionality was described not for the purpose of defining specific requirements but to explore ways in which the rights and obligations could be supported, and determine whether they are reasonable and feasible.

Open Market Option Use Case Scenarios

The open market option use case scenarios focus on two areas. The first is the interaction between the customer, the utility and its RDS system, and a Title 24 PCT in the customer premise for receiving and responding to emergency and real-time price signals. The second area is the process of preparing the Title 24 PCT to be able to recognize the correct RDS signals. Table 2 lists the open market option use case scenarios developed. The full set of the open market option use case scenarios can be found in Appendix B, page #.

Use Case #	Use Case Name – The Primary Actor's Goal with the System	Scope Level
1.1	Receive price and emergency RDS signals	Summary
1.1.1	Receive non-overridable emergency RDS signals	Scenario
1.1.2	Receive real time price RDS signals	Scenario
1.1.3a/b	Program Title 24 PCT to recognize correct RDS price signals	Scenario
1.1.4	Register Title 24 PCT to recognize correct RDS signals	Scenario

Table 2. Open Market Option Use Case Scenarios

Utility Programs Option Use Case Scenarios

The utility programs option use case scenarios also focus on two areas. The first is the interaction between the customer, the utility and its AMI system, and equipment in the customer premise for receiving and responding to emergency and real-time price signals. The second area of focus is the process of enrolling in a utility program to explore customer and

utility rights and obligations in different scenarios. Table 3 lists the utility programs option use case scenarios developed. The full set of the utility programs option use case scenarios can be found in Appendix B, page #.

Use Case #	Use Case Name – The Primary Actor's Goal	Scope Level
2.1	Receive price and emergency signals through the AMI system	Summary
2.1.1	Receive non-overridable emergency AMI signals	Scenario
2.1.2	Receive real-time price AMI signals	Scenario
2.2	Enroll in utility DR program or change enrollment	Summary
2.2.1	Enroll in utility DR program with no existing PCT or HAN	Scenario
2.2.2	Enroll in utility DR program with existing HAN using a different communication protocol than utility AMI system	Scenario
2.2.3	Change connection to AMI by signing up with a 3rd party load aggregator	Scenario

Table 3. Utility Programs Option Use Case Scenarios

3.3. Rights and Obligations

Throughout the development of the different models, customer, utility and vendor rights and obligations were identified and evaluated. The method of defining policy guidelines by identifying rights and obligations of all parties involved in a process is based on the work of T.D.Breaux and A.I.Anton at North Carolina State University. Their approach involves analyzing existing regulations, developing semantic models of them, and then extracting and balancing rights and obligations in order to clarify ambiguities in the regulations. The authors discuss future work where the development of rights and obligations would begin the process and play a direct role in the authorship of policy guildelines[3] which is the approach taken in this project.

Activity models of balanced right-obligation pairs were created to identify implicit rights and obligations that were not in the original set and to improve the logical expression of the rights and obligations. Table 4 shows how a right is mapped to its balancing obligation. All the activity models of balanced right-obligation pairs can be found in Appendix C.

Activity Model 1	Right 1	Obligation 1
Actor	Customer	Utility

Action	receive	provide
Object	real-time price & emergency signals	real-time price & emergency signals
Purpose (optional)	save money, avoid outages	manage loads & avoid outages
Target (optional)	Title 24 PCT	Title 24 PCT
Method (optional)	using RDS system	using RDS system

Table 4. Activity Model for Balanced Right-Obligation pair

After a final evaluation and reworking, the following rights and obligations were identified as essential to the open market option and the utility programs option.

R1. Customers have the right to receive price (periodic and real-time) signals and reliability signals without enrolling in utility programs and without registering their equipment with their utility.

O1. Utilities are obligated to broadcast price and reliability signals as defined in 2008 Title 24 Standard for programmable communicating thermostats[4] which can be received by customer equipment that is neither registered with the utility nor used in a utility program.

R2. Customers have the right to purchase, rent or otherwise select from any vendor any and all devices and services used in their premise.

O2. Utilities are obligated to provide an AMI communication system that uses an open communication protocol and does not unduly restrict customer choice of customer equipment or services that support performing DR.

R3. Vendors have the right to compete in an open market to sell HAN systems, devices and services to all utility customers.

O3. Utilities are obligated to not extend their regulatory franchise beyond its intended domain into competitive areas.

R4: Utilities have the right to offer demand response programs and energy management services to customers which utilize the informational and communication capabilities of their AMI system.

O4. Customers participating in utility programs are obligated to maintain correct working of customer equipment that communicates with the AMI system and provide a communications translation device if needed.

4.0 Conclusions and Recommendations

4.1. Conclusions

The information modeling and analysis of the utility AMI – customer equipment interface has allowed the group to define and verify the customer, utility and vendor rights and obligations that need to be supported by California IOU's AMI systems.

Analysis and modeling of the UtilityAMI OpenHAN document shows an AMI system that only supports customer participation in utility programs and does not include the open market option.

To foster the widest support for the state Energy Action Plan II and the most effective utility DR rates and programs, both the open market option and the utility programs option need to be supported.

4.2. Recommendations

As a result of these findings, it is recommended that the customer, utility and vendor rights and obligations defined in this report should be established as the primary requirement to govern all California IOU proposals for the interface between their AMI system, and the California residential electricity customer and their equipment. It is also recommended that the California utilities use case scenarios should demonstrate how they will provide the open market option to supports the customer and vendor rights defined in this report

4.3. Benefits to California

DR, a critical component of the California's Energy Action Plan II, has the potential to increase reliability of the California's electric grid and avoid the expense of building new generation capacity to meet peak demand. The success of DR depends to a large extent on how the utilities implement their Advance Metering Infrastructure systems. The rights and obligations in the AMI customer equipment interface recommended as policy guidelines in this report, if adopted will ensure that California IOU's include in their AMI configuration and DR offerings more opportunities for customers to participate in DR. It is envisioned that increasing customer opportunities to participate in DR will result in more effective DR in California.

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6.0 Glossary

The following are definitions for terms, phrases, acronyms and abbreviations used in this report

AMI	advanced metering infrastructure including interval meters, communications, back-office software, implemented by the utility
customer	residential customer
customer equipment	equipment in the customer premise including thermostats, pool pumps, appliances, gateways, routers, TV monitors, health monitors, computers
DR	demand response
HAN	home area network or home automation network of customer equipment
OpenHAN document	Joint IOU HAN Use Case Definitions / Assumptions / Actors", produced by the UtilityAMI OpenHAN task force
open market option	customer equipment interface that provides unrestricted access to utility price and reliability signals via communication channels available to the open market which must include RDS broadcast and may include broadband communication e.g. internet. This option does not require the customer to enroll in a program or register their equipment in order to get the signal.
PCT	Programmable Communicating Thermostat
RDS	Radio Data System
regulator	California Energy Commission and California Public Utility Commission regulatory bodies
Title 24 PCT	A PCT that is compliant with California Title 24 2008 standards

utility	California investor-owned utilities
utility programs option	utility AMI – customer equipment interface that provides access to utility price and reliability signals via utility controlled communication channels and requires customer to enroll in a utility program order to get the signal.
vendors	vendors & service providers of HAN or DR related products and services

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3. CA IOU's Industry Standard HAN Development CPUC and CEC Update, June 26, 2007 PowerPoint presentation

State of Demand Response in California, Ahmad Faruqui and Ryan Hledik, The Brattle Group, Draft 4/07 CEC 200-2007-003D

CPUC OIR's including those in process:

Rulemaking 02-06-001 (Filed June 6, 2002)Order Instituting Rulemaking on policies and practices for advanced metering, demand response, and dynamic pricing.

2/19/04 JOINT ASSIGNED COMMISSIONER AND ADMINISTRATIVE LAW JUDGE'S RULING PROVIDING GUIDANCE FOR THE ADVANCED METERING INFRASTRUCTURE BUSINESS CASE ANALYSIS

7/21/2004 ADMINISTRATIVE LAW JUDGE AND ASSIGNED COMMISSIONER'S RULING ADOPTING A BUSINESS CASE ANALYSIS FRAMEWORK FOR ADVANCED METERING INFRASTRUCTURE [particularly the scenarios in Attachment A]

ORDER ADOPTING CHANGES TO 2007 UTILITY DEMAND RESPONSE PROGRAMS, Decision 06-11-049 November 30, 2006

Order Instituting Rulemaking Regarding Policies and Protocols for Demand Response Load Impact Estimates, Cost-Effectiveness Methodologies, Megawatt Goals and Alignment with California Independent System Operator Market Design Protocols DRAFT

Appendix A: Project Charter

Mission Statement

Provide guidance and clear policy direction to encourage customer-driven DR and EE by developing a system that provides pricing, reliability and load information available to all

Objectives

Create regulatory use cases based on these premises:

- Price and reliability signals should be available to all
- Utility AMI requirements should not unduly control the HAN market

From the use cases, extract applicable rights and obligations of customers, vendors and utilities, and develop guiding principles for regulating utilities AMI communications with customers

Assess whether the proposed AMI-HAN configuration defined in the OpenHAN use case material satisfies these rights and obligations of customers, vendors and utilities

Critical Success Factors

This project will be a success if:

- CSF 1: Guiding principles are provided to and used by utilities and the CPUC.
- CSF 2: The CPUC agrees with CEC vision expressed in the guiding principles and uses them to encourage utilities to modify their AMI communication system design.
- CSF 3: Utilities change their AMI specifications to include the broadcasting of price and reliability signals to any HAN network.
- CSF 4: Customers receive signals that facilitate an automatic response to price without actively participating in a program.
- CSF 5: Application of guiding principles results in enhanced DR and efficiency from customers.

Critical Risks & Issues

Project success is jeopardized by:

- CRI 1: The very small window of opportunity (3 weeks) to produce enough of project deliverables be considered by CPUC and utilities in the AMI design decisions.

- CRI 2: Utilities ambiguous usage of HAN throughout their use cases makes it difficult in this project to identify and communicate a clear, decisive, unambiguous "bright line" between the AMI and HAN domains

- CRI 3: the possibility that CPUC will not understand or agree to the guiding principles developed in this project

Stakeholders

End Users of project results

CEC: Dave Hungerford in his communications with CPUC and utilities

CPUC:

California investor owned utilities: SCE, SDG&E, PG&E

Creators of use cases and project materials

PI: Diane Pepetone

Project team: Dave Hungerford, Margaret Sheridan, Kristy Chew, Roger Levy, Ron Hofmann

Advisors on project:

T24 PCT standards: Maziar Shirakh, CEC; Karen Herter, H-M-G

OpenHAN & CA IOU's: Erich Gunther, Enernex

Sponsor of project:

PIER ESI: Mike Gravely, CEC

Appendix B: Use Case Scenarios

Use Case ID: 1.1.1

Use Case Name: Receive non-overridable emergency RDS signals

Primary Actor: California residential electricity customer, referred to as Customer

Secondary Actor: Title 24 PCT using built-in RDS, referred to as T24 PCT

System: California investor-owned utility & their systems, referred to as Utility

Preconditions: A last stage non-overridable emergency event has occurred.

California's RDS system is operational.

T24 PCT is programmed and ready to receive RDS signals.

Scenario:

Step #	Performed by	Action performed
1	Utility	Sends emergency start signal through the RDS system
2	T24 PCT	Receives emergency start RDS signal
3	T24 PCT	Performs check which shows that it should respond to the signal
4	T24 PCT	Responds as programmed to curtail load and displays emergency signal alarms
5	Customer	Turns off other loads in response to T24 PCT emergency indications
6	Utility	Sends emergency stop RDS signal
7	T24 PCT	Receives emergency stop RDS signal
8	T24 PCT	Performs check which shows that it should respond to the signal
9	T24 PCT	Returns to normal load profile & indicates emergency is over
10	Customer	Turns loads back to normal after noticing emergency is over
11	Utility	Measures electricity use for billing
Alternate Scenario 1		
3a	T24 PCT	Performs check which shows that it should **not** respond to the signal
11	…	

Rights: Customers have a right to receive non-overridable emergency signals using the RDS system built into the Title 24 PCT.

Obligations: Utilities are obligated to provide non-overridable emergency signals using the RDS system used by Title 24 PCT's in addition to their preferred AMI communication methodology to reach the widest number of customers and avoid outages.

Use Case ID: 1.1.2

Use Case Name: Receive real-time price RDS signals

Primary Actor: California residential electricity customer, referred to as Customer

Secondary Actor: Title 24 PCT using built-in RDS, referred to as T24 PCT

System: California investor-owned utility & their systems, referred to as Utility

Preconditions: Utility's RDS system is operational.

T24 PCT is programmed and ready to receive RDS signals.

Customer is on the utility real-time price tariff.

Scenario:

Step #	Performed by	Action performed
1	Utility	Sends real-time price RDS signal with a price that is very high due to peak loads
2	T24 PCT	Receives the real-time price RDS signal
3	T24 PCT	Performs check which shows that it should respond to the signal
4	T24 PCT	Responds as programmed by curtailing loads and displays the new price indicating that it is very high
5	Customer	Turns off other loads in response to very high price indication
6	Utility	Sends real-time price RDS signal with a lower price
7	T24 PCT	Receives real-time price RDS signal
8	T24 PCT	Performs check which shows that it should respond to the signal
9	T24 PCT	Responds as programmed, displays the new lower price
10	Customer	Turns loads back to normal after noticing price decrease
11	Utility	Measures electricity use for billing
Alternate Scenario 1		
3a	T24 PCT	Performs check which shows that it should **not** respond to the signal
11	…	

Rights: Customers have a right to receive real-time price signals using the RDS system built into the Title 24 PCT.

Customers have a right to be on a real-time price tariff with minimum effort.

Obligations: Utilities are obligated to send real time price signals through RDS as well as the utility's AMI communication system

Utilities are obligated to provide a real-time price rate that is easily accessible to all customers.

Utilities are obligated to provide a real-time price rate as the default rate to encourage customer DR participation by eliminating any extra steps to be on real-time rate.

Use Case ID: 1.1.3a

Use Case Name: Program Title 24 PCT to recognize correct RDS signals

Primary Actor: California residential electricity customer; referred to as Customer

Secondary Actor: Title 24 PCT using built-in RDS; referred to as T24 PCT

System: California investor-owned utility & their systems, referred to as Utility

Preconditions: Utility's RDS system is operational.

Utility's RDS system only carries the default dynamic price rate.

Customer is on the default dynamic price rate.

Scenario:

Step #	Performed by	Action performed
1	Utility	Sends Customer utility-location identifier for programming a Title 24 PCT to recognize the correct RDS signals
2	Customer	Enters the utility-location code into the T24 PCT
3	Utility	Sends default dynamic price RDS signal
4	T24 PCT	Receives default dynamic price RDS signal
5	T24 PCT	Performs check using programmed information to see if the signal contains the programmed utility-location code and if it does, it responds

Use Case ID: 1.1.3b

Use Case Name: Program Title 24 PCT to recognize correct RDS signals

Primary Actor: California residential electricity customer; referred to as Customer

Secondary Actor: Title 24 PCT using built-in RDS; referred to as T24 PCT

System: California investor-owned utility & their systems, referred to as Utility

Preconditions: Utility's RDS system is operational.

Utility's RDS system carries several dynamic price rates.

Customer is on the default dynamic price rate and eligible for others.

Scenario:

Step #	Performed by	Action performed
1	Utility	Sends Customer information for programming a Title 24 PCT to recognize the correct RDS signals. This includes utility-location code and rate codes that the Customer is eligible for
2	Customer	Enters the utility-location code and rate codes into the T24 PCT
3	Utility	Sends a dynamic price RDS signal

4	T24 PCT	Receives dynamic price RDS signal
5	T24 PCT	Performs check using programmed information to see if the signal contains the programmed utility-location code and any of the programmed rate codes and if it does, it responds

Rights: Customers have a right to program their Title 24 PCT to recognize the correct RDS signals without having to supply the utility with personal information

Use Case ID: 1.1.4

Use Case Name: Register Title 24 PCT to recognize correct RDS signals

Primary Actor: California residential electricity customer; referred to as Customer

Secondary Actor: Title 24 PCT using built-in RDS; referred to as T24 PCT

System: California investor-owned utility & their systems, referred to as Utility

Preconditions: Utility's RDS system is operational.

T24 PCT has a factory set unique ID that can be displayed.

Utility includes registered Title 24 PCT unique IDs in RDS signals.

Scenario:

Step #	Performed by	Action performed
1	Utility	Sends Customer Title 24 PCT registration instructions which include number to call and the utility-location code
2	Customer	Gets unique ID from T24 PCT
3	Customer	Calls the Utility's registration number
4	Utility	Asks for Customer account number and T24 PCT unique ID
5	Customer	Gives their account number and the T24 PCT unique ID
6	Utility	Arranges to include the Customer's T24 PCT unique ID in RDS signals carrying price rates the Customer is eligible for
7	Customer	Enters the utility-location code into the T24 PCT
8	Utility	Sends RDS signal
9	T24 PCT	Receives RDS signal
10	T24 PCT	Performs check to see if the signal contains its unique ID and the programmed utility-location code and if it does, it responds

Use Case ID: 2.1.1

Use Case Name: Receive non-overridable emergency AMI signals

Primary Actor: California residential electricity customer, referred to as Customer

Secondary Actor: Title 24 PCT using utility AMI communications, referred to as T24 PCT

System: California investor-owned utility & their systems, referred to as Utility

Preconditions: A last stage non-overridable emergency event has occurred.

Utility's AMI system is operational.

Customer is enrolled in a utility DR program.

T24 PCT is registered, programmed and ready to receive AMI signals.

Scenario:

Step #	Performed by	Action performed
1	Utility	Sends emergency start AMI signal
2	T24 PCT	Receives emergency start AMI signal & returns acknowledgment
3	T24 PCT	Responds as programmed to curtail load and displays emergency signal alarms
4	T24 PCT	Sends information to AMI system on actions taken
5	Customer	Turns off other loads in response to T24 PCT emergency indications
6	Utility	Sends emergency stop AMI signal
7	T24 PCT	Receives emergency stop AMI signal & returns acknowledgment
8	T24 PCT	Returns to normal load profile and indicates emergency is over
9	T24 PCT	Sends information to AMI system on actions taken
10	Customer	Turns loads back to normal after noticing emergency is over
11	Utility	Measures electricity use for billing

Use Case ID: 2.1.2

Use Case Name: Receive real-time price AMI signals

Primary Actor: California residential electricity customer, referred to as Customer

Secondary Actor: Title 24 PCT using utility AMI communications, referred to as T24 PCT

System: California investor-owned utility & their systems, referred to as Utility

Preconditions: Utility's AMI system is operational.

T24 PCT is registered, programmed and ready to receive AMI signals.

Customer is enrolled in a utility DR program.

Scenario:

Step #	Performed by	Action performed

1	Utility	Sends real-time price AMI signal with a price that is very high due to peak loads
2	T24 PCT	Receives the real-time price AMI signal & sends acknowledgement
4	T24 PCT	Responds as programmed by curtailing loads and displays the new price indicating that it is very high
5	T24 PCT	Sends information to AMI system on actions taken
6	Customer	Turns off other loads in response to very high price indication
7	Utility	Sends real-time price AMI signal with a lower price
8	T24 PCT	Receives real-time price AMI signal & sends acknowledgement
10	T24 PCT	Responds as programmed, displays the new lower price
11	T24 PCT	Sends information to AMI system on actions taken
12	Customer	Turns loads back to normal after noticing price decrease
13	Utility	Measures electricity use for billing

Use Case ID: 2.2.1

Use Case Name: Enroll in utility DR program without a Title 24 PCT

Primary Actor: California residential electricity customer; referred to as Customer

System: California investor-owned utility & their systems, referred to as Utility

Preconditions: Customer does not have an existing Title 24 PCT

Scenario:

Step #	Performed by	Action performed
1	Utility	Sends Customer information about DR program offerings
2	Customer	Enrolls in a DR program
3	Customer	Purchases Title 24 PCT w/ AMI communication module from Utility
4	Utility	Tests and registers Title 24 PCT with the AMI communication system
5	Customer	Programs Title 24 PCT with personal settings if different from defaults
Alternate Scenario 1		
3a	Utility	Provides the Customer with a Title 24 PCT with AMI communication module inserted, tested and registered with their AMI system
5…		
Alternate Scenario 2		
3a	Customer	Purchases Title 24 PCT with built-in RDS communication system from retail store
3b	Utility	Provides Customer with AMI communication module
3c	Customer	Installs AMI communication module in their Title 24 PCT
4…		
Alternate Scenario 3		
2a	Customer	Enrolls in a DR program with PCT which is not a Title 24 compliant
2b	Utility	Tells Customer they must use a Title 24 PCT
3…		

Rights: Customers have the right to purchase and use Title 24 compliant PCTs of their own choosing for participating in utility DR programs.

Utilities have a right to require that customers enrolled in a utility DR program use Title 24 PCT's that can communicate using the AMI communication protocol.

Obligations: Customers are obligated to use a Title 24 compliant PCT if they enroll in a utility DR program.

Question: In Step 3, do utilities have a right to sell or charge for Title 24 PCT's as part of their DR programs?

Note: Utilities are not obligated to provide customers with Title 24 PCT if the customers enroll in a program and do not have a Title 24 PCT. However, most utilities are including a Title 24 PCT in their programs if customers do not have a means of receiving the signal.

Use Case ID: 2.2.2

Use Case Name: Enroll in utility DR program with existing HAN that does not use the utility's AMI communication protocol

Primary Actor: California residential electricity customer; referred to as Customer

System: California investor-owned utility & their systems, referred to as Utility

Preconditions: Customer has an existing HAN with Title 24 PCT and the HAN uses a different communication protocol than the utility AMI system.

Scenario:

Step #	Performed by	Action performed
1	Utility	Sends Customer information about Dr program offerings
2	Customer	Enrolls in the Utility's DR program, with their existing HAN
3	Utility	Finds that HAN does not use the AMI communication protocol and tells Customer that they must provide a translation device for communication between the HAN and the utility AMI system
4	Customer	Purchases and installs translation device to connect AMI to HAN
5	Utility	Tests communication between AMI meter and HAN and tests & registers the Title 24 PCT
Alternate Scenario 1		
3a	Customer	Decides to enroll with just the Title 24 PCT and disconnects it from the HAN
4a	Utility or Customer	Gets and inserts an AMI communication module into Title 24 PCT
5a	Utility	Tests & registers PCT with their AMI system

Rights: Customers have a right to choose what translation device they use in their system to communicate between the utility AMI and their HAN.

Obligations: Customers are obligated to provide and operate a translation device if they are enrolled in a utility DR program and their HAN does not use the utility AMI communication protocol.

Use Case ID: 2.4

Use Case Name: Change connection to AMI by signing up with a 3rd party load aggregator who will provide price & reliability signaling

Primary Actor: California residential electricity customer; referred to as Customer

System: California investor-owned utility & their systems, referred to as Utility

Preconditions: Customer already enrolled in utility DR program that works with their Title 24 PCT.

Scenario:

Step #	Performed by	Action performed
1	Customer	Notifies Utility that they are discontinuing their enrollment in the DR program after this billing month.
2	Utility	Responds with information on the date when the Customer will be dropped from the program.
3	Customer	Completes contract and all installment procedures to test 3rd party load aggregator's price / reliability signal and response functionality
4	Utility	Drops Customer from DR program and disables the AMI meter DR communication capability
Alternate Scenario 1		
1a	Customer	Notifies Utility that they are signing up with w 3rd party aggregator but want to continue participating in the Utility DR program.
2a	Utility	Informs the Customer that they can stay in the DR program.
3	…	

Obligations: Utilities are obligated to structure their DR programs to ensure that the same load isn't sold twice.

Appendix C: Right and Obligation Activity Models