Development and Demonstration of the Open Automated Demand Response Standard for the Residential Sector

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Abstract

The goal of this study was to demonstrate a demand response system that can signal nearly every customer in all sectors through the integration of two widely available and non-proprietary communications technologies—Open Automated Demand Response (OpenADR) over Internet protocol and Utility Messaging Channel (UMC) over FM radio. The outcomes of this project were as follows: (1) a software bridge to allow translation of pricing signals from OpenADR to UMC; and (2) a portable demonstration unit with an Internet-connected notebook computer, a portfolio of DR-enabling technologies, and a model home. The demonstration unit provides visitors the opportunity to send electricity-pricing information over the Internet (through OpenADR and UMC) and then watch as the model appliances and lighting respond to the signals. The integration of OpenADR and UMC completed and demonstrated in this study enables utilities to send hourly or sub-hourly electricity pricing information simultaneously to the residential, commercial and industrial sectors.

Keywords: residential, peak demand, demand response, dynamic pricing, event notification, automated response, control technology, OpenADR, Open Automated Demand Response

Executive Summary

Introduction

In December of 2008, the California Energy Commission proposed a portfolio of Load Management Standards directed at encouraging a ubiquitous electric demand response network. Included in the proposed standards are requirements directing all California investor-owned utilities and municipals to "…establish a standard method for transmitting current rate and reliability information to customers," and to "…develop programs supporting customer adoption of enabling technologies… capable of facilitating customer load reductions responding to dynamic prices using the Open Automated Demand Response communication standard internet protocol."

The Open Automated Demand Response standard is a flexible, open-standard information model that has been used since 2001 to send electricity pricing and event information to energy management control systems in large commercial and industrial buildings. Technically, this model can be used for residential applications; however, it requires Internet connectivity, which is not yet ubiquitous in the residential sector. To address this potential shortfall, this project was designed to broaden the reach of Open Automated Demand Response signals by providing a link to a communications technology that is nearly ubiquitous in all sectors: FM radio.

Purpose

The objectives of this study were to:

1. Work with communications vendors to develop a software bridge from *Open Automated Demand Response*, an information model designed for two-way communications over the Internet, to the *Utility Message Channel*, an information model designed for one-way broadcast over FM radio.
2. Assemble a portable demonstration unit that can initiate a real price event via Internet and FM radio, receive the pricing signals across a variety of communicating control technologies, and model the potential response of residential appliances and lighting.

The ultimate goal of this study was to demonstrate an example demand response system, consisting of two widely available and non-proprietary communications technologies, capable of delivering electricity pricing and events signals to a variety of mass-market devices.

Project Outcomes

The Open Automated Demand Response system and the Utility Message Channel system were successfully integrated such that electricity-pricing notifications can now be sent to groups of devices by the Internet and FM radio, simultaneously. A portable unit was constructed to demonstrate this capability.

Recommendations

The ADR-UMC system should be considered an option in all future utility plans for customer notification of electricity pricing, given its low-cost, wide broadcast range, open protocol, and support from the National Institute of Standards and Technology.

Benefits to California

The integrated ADR-UMC system is now a viable option for broadcasting hourly or sub-hourly pricing information. It has the potential to keep the costs of new electric pricing programs low, while offering a secure, non-proprietary system with near universal customer coverage.

1.0 Introduction

In December of 2008, the California Energy Commission proposed a portfolio of Load Management Standards directed at encouraging a ubiquitous electric demand response (DR) network as part of the future SmartGrid. Included in the proposed standards are requirements directing all California investor-owned utilities and municipals to:

"…establish a standard method [information model] for transmitting current rate and reliability information to customers," and to

"…develop programs supporting customer adoption of enabling technologies… capable of facilitating customer load reductions responding to dynamic prices using the Open Automated Demand Response communication standard internet protocol."

Open Automated Demand Response, otherwise known as OpenADR or ADR, is an information model based on eXtensible Markup Language (XML), and uses the public Internet as its communications channel. OpenADR was developed by Lawrence Berkeley National Laboratory, and has been used since 2001 to send electricity pricing and event information to energy management control systems in large commercial and industrial buildings (Piette et al. 2009).

Utility Message Channel (UMC) is an information model used to broadcast demand response event and pricing information over Radio Data System (RDS), an FM-based communications channel. For decades, RDS has been used primarily to display music and traffic information in automobiles. More recently, it has been used to send UMC pricing and event information to thermostats in the residential and small commercial sectors (Herter and Wayland 2008; Herter et al. 2009)

The first objective of this study was to develop and demonstrate an integration of the OpenADR and UMC information models, thus allowing simultaneous DR event messaging to the residential, small commercial, large commercial and industrial sectors. The integration required a mapping from the OpenADR information model to the UMC information model using a software bridge, referred to here as the *ADR-UMC bridge*.

The second objective of this study was to design and build a demonstration unit showing control of appliances and lighting using the new ADR-UMC notification system. The demonstration unit contains an Internet connected laptop and a portfolio of OpenADR and UMC-compliant devices. Visitors to the display can use the netbook computer to send a DR pricing event signal through the OpenADR user interface, and then watch in real time as the model appliances and lighting respond to the incoming ADR and UMC signals.

2.0 Project Approach

The first objective of this study was to develop and demonstrate an integration of the OpenADR and UMC information models, thus allowing simultaneous DR event messaging to the residential, small commercial, large commercial and industrial sectors. The integration required a mapping from the OpenADR information model to the UMC information model using a software bridge, referred to here as the *ADR-UMC bridge*. The second objective of this study was to create a demonstration unit showing control of appliances and lighting using the new ADR-UMC notification system. The following sections describe the details of the approach used to meet these two objectives.

2.1. Information and Communications

The integration of the OpenADR and UMC price notification systems required a translation of the OpenADR data model to the UMC data model. This approach allows pricing information to be sent from the OpenADR interface through the UMC servers, and then to be broadcast over the FM airwaves. This section describes the two data models, their functionality, and the final set of functions to be derived from the integrated system.

2.1.1. Open Automated Demand Response (OpenADR)

OpenADR is a data model used to communicate price schedules, DR events, and grid stability information from utilities to ADR-compatible devices over the Internet, using encrypted connections for privacy and security. OpenADR signals are sent through a Demand Response Automation Server (DRAS), and reach OpenADR-ready devices through *push* or *pull* operations. In a data *push*, the DRAS contacts the customer's device and sends (or pushes) an update. In a data *pull*, the customer's device contacts the DRAS and requests (or pulls) an update. OpenADR is an open standard, which means that anyone can freely implement the standard without a license. Implemented correctly, the standard allows devices from various vendors to work together seamlessly (Piette et al. 2009).

This project made use of OpenADR's *Price Schedule* messaging feature, which assigns a list of prices (in $) to the associated start and end times. Because some control devices accept only *Price Tier* information—where prices are simplified as one of four categorical levels (e.g. low, medium, high, and critical)—the DRAS software was modified to allow translation of Price Schedules into Price-Tier schedules (Figure 1). In use, the assignment of prices to tier categories will require a utility defined mapping. Note that the data shown in Figure 1 is a simplified subset of the full OpenADR information set, which includes date, more precise timing information, and message identification.

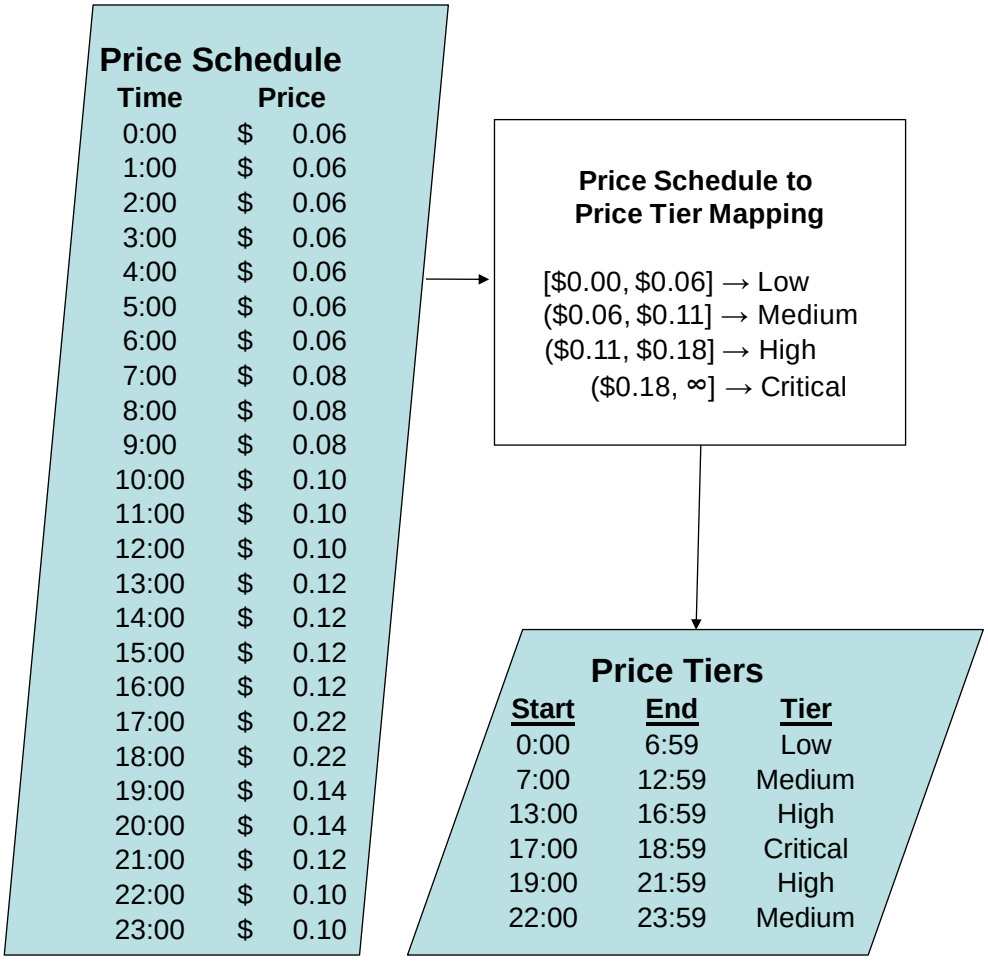

Figure 1. OpenADR price schedule to price tier conversion

Figure 2 outlines the infrastructure and process used for transmitting OpenADR pricing information. A price schedule is manually entered into the web-based Demand Response Automation Server Interface (the DRAS). The DRAS then generates a price-tier schedule, and sends both the price schedule and price-tier messages to targeted OpenADR devices over the Internet.

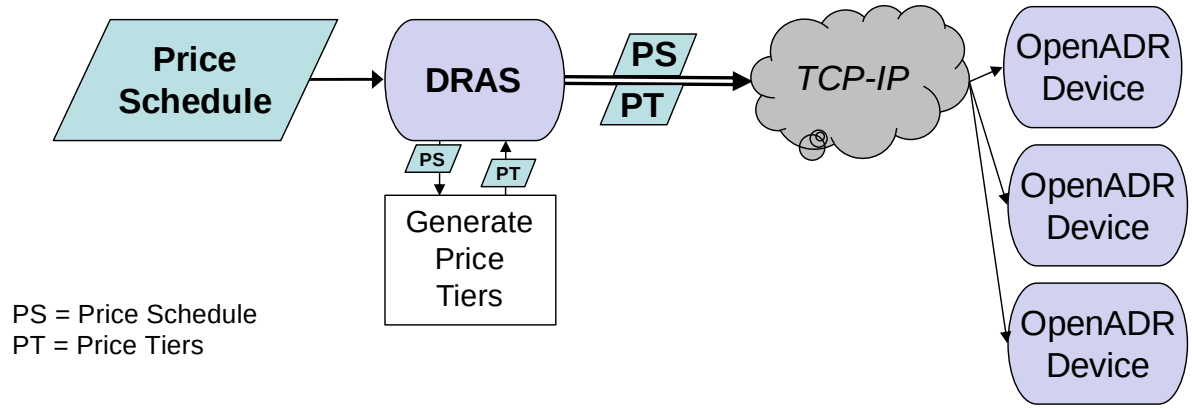

Figure 2. OpenADR communication overview

2.1.2. Utility Message Channel (UMC)

Radio Data System, or RDS, is a European Broadcasting Union standard for sending small amounts of digital information using conventional FM radio broadcasts. RDS uses a 57 kHz subcarrier to transmit data at over 1,000 bits per second with error correction. RDS does not cause interference or inter-modulation with FM stereo signals and has been commonly used in Europe and Latin America since the early 1990s. The U.S. version of RDS is officially called the Radio Broadcast Data System (RBDS), but the acronym RDS is commonly used to refer to RBDS in the U.S. The RDS system was originally designed to send data related to musical broadcasts: time, artist info, and station identification. In recent years, RDS has been shown to be a viable mechanism for broadcasting DR pricing and event signals (Herter and Wayland 2008; Herter et al. 2009).

A 2008 study tested the signal strength and reliability of RDS signals at 40 customer sites within the Sacramento Municipal Utility District, which is serviced by 17 radio stations that already transmit RDS signals. Test results demonstrated that RDS is capable of reliably broadcasting price and emergency signals to residential and small commercial buildings with greater than 95 percent probability of reception when signals are broadcast from just two radio stations (Herter and Wayland 2008).

The Utility Message Channel (UMC) is the information model used for demand response over RDS. UMC can be used to send price and event information in multiple formats: price schedule, price tier, thermostat offset, and thermostat setpoint change. It can also transmit binary data in order to tunnel a proprietary protocol via RDS. Figure 3 illustrates the flow of data from the web-based price schedule input through the UMC server to the FM broadcast tower, and out to UMC-enabled devices.

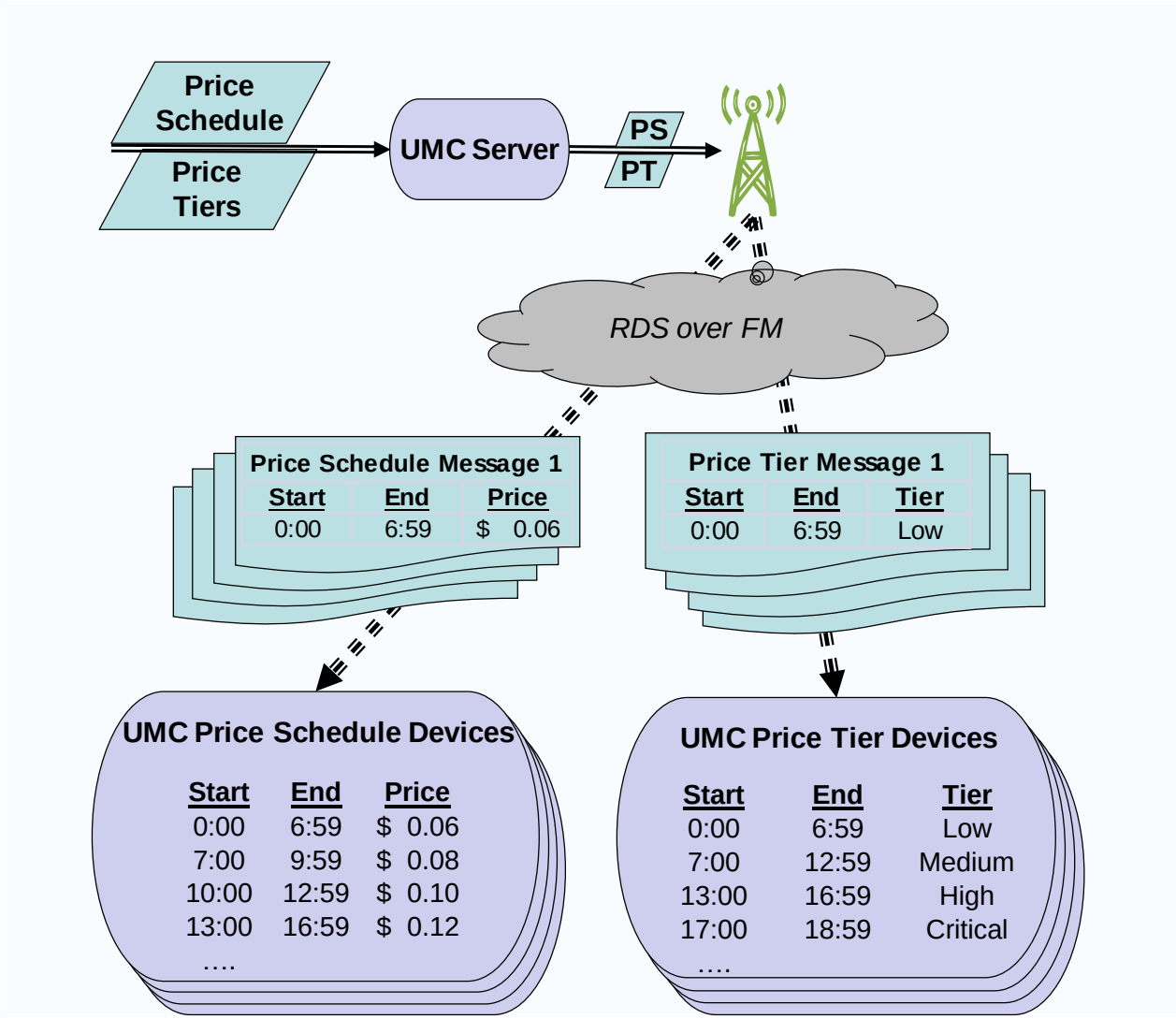

Figure 3. RDS transmission of price schedules and price tiers

RDS targets subsets of RDS-ready devices with message group and service group IDs. Message group IDs can be specific to a utility or utility program. Service group IDs are specific to device types: for this project either price aware or price-tier aware. Unique service IDs will specify which message types a device can receive and act upon. The RDS group and service IDs used in this project will be defined during project development and listed in the final report.

2.1.3. Integrated OpenADR-UMC Functionality

UMC and OpenADR transmit a similar, but not identical set of messages. The maximum functionality of the integrated OpenADR-UMC system is limited to the intersection of these two sets of functions. At the time this project was conducted, there were four functions that existed in both OpenADR and UMC as shown in Table 1: price schedule, price tier, cancel event, and modify event. All four of these functions were included in the ADR-UMC function set.

Table 1. OpenADR, UMC, and ADR-UMC Messages

Function	OpenADR	UMC	ADR-UMC
Price Schedule	Can accommodate up to one price per minute	Each message allows four time periods/prices; but messages can be combined to allow an unlimited number of periods/prices	Yes
Price Tier	Added to OpenADR as part of this project.	Allows up to 4 Tiers, where Tiers 1-3 are commonly used for time of use prices and Tier 4 is used as a CPP event.	Yes
Relative Price	-	Allows a base price with 3 multipliers	No
Temperature Offset	-	Each message provides one offset (in degrees) from existing thermostat setpoint.	No
Set Temperature	-	Each message provides one setpoint (in degrees) to be applied to all devices in the group.	No
Display Message	-	Free-text message limited to 36 characters.	No
Cancel Event	Removes previous message (price schedule or tier)	Removes the previous message (price schedule or tier)	Yes
Modify Event	Update price schedule	Cancel a previous message and send a new one.	Yes
Bidding Information	Sends information about timing of the auction (i.e. opening and closing times)	-	No
Receipt Notification	Additional information can be sent back as well.	-	No

Following are brief descriptions of the four elements included in the OpenADR-UMC system.

- *Price Schedule*. A data package containing a list of start times, end times, and actual electricity prices in those periods.
- *Price Tiers*. A data package containing a list of start times, end times, and categorical representations of electricity prices in those periods.
- *Cancel Event*. The previous price message (schedule or tier) is removed. Price values revert back to the baseline.
- *Modify Events*. Change the periods or prices in a previously sent message.

2.2. Information and Control Devices

Five devices were chosen to demonstrate the functionality of the completed OpenADR-UMC system: one responds directly to the OpenADR signal, three respond to the UMC signal, and one is a local monitoring and information device that does not respond to the ADR-UMC signal. Following are brief descriptions of the five devices used in this project. *EnergyHub Load Monitor and Display*. The EnergyHub device monitors plug-loads using a Wi-Fi connection between the dashboard display and the plug-load monitors.

- *Entek RDS Load Switch*. This device can be used to control power to just about any device, including large loads like air conditioning compressor units, pool pumps, and water heaters.
- *General Electric (GE) UMC Router*. GE's UMC router is a controller designed to interface with any one of the numerous GE appliances that have demand response capabilities: a Home Energy Monitor, a clothes washer, clothes dryer, dishwasher, water heater, refrigerator, microwave, and range.
- *Residential Control Systems TE43 Communicating Thermostat*. The TE43 is designed to respond to UMC price event signals, triggering temperature setpoint changes of between zero and nine degrees, as programmed by the end user.
- *Universal Devices ISY-99i Controller*. The ISY-99i receives OpenADR signals and connects with a variety of modular INSTEON devices to limit or stop power flow to plug loads.

Section 3.0 provides more detailed overviews of each device along with descriptions of how each was used in the demonstration.

Table 2 outlines the basic communication features of each device used in this project.

Table 2. Information and control devices used to demonstrate the OpenADR-UMC price notification system

Company	Device	Reception from utility	Connection to local devices
Energy Hub	Load Monitor and Display	None	Wireless (Wifi)
Entek	Load Control Switch	UMC	Wired
General Electric	UMC Router	UMC	Wired
Residential Control Systems	TE43 Communicating Thermostat	UMC	Wired
Universal Devices	ISY-99i Controller	OpenADR	Wireless (INSTEON)

2.3. Demo Unit Construction

The demonstration unit was to be a self-contained, yet portable unit that showed in real-time the potential use of the ADR-UMC system. To this end, the unit must contain three basic components. First, OpenADR signaling requires a connection to the Internet, readily accomplished using a small netbook computer with Internet capability. Second, the unit must have the information and display devices (described in the previous section) attached and set up to receive the OpenADR and UMC signals that originate from the netbook computer. Third, the demonstration unit must indicate the potential response of home appliances and lighting to the price event signal. The plan for this last element was to create a model home with visual indicators for the on and off cycles of appliances—miniature lighting fixtures, red LEDs to indicate heating, blue LEDs to indicate cooling, a fan to represent the air-conditioning blower, and a small pump blowing air into a container of water to represent a spa or swimming pool—all wired to dim or turn off at price levels chosen by the research team (but ultimately chosen by the consumer). Finally, all of these elements would need to be combined into a unit that could be easily transported. This last task was completed with the help of an outside contractor.

3.0 Project Outcomes

3.1. Communications

The ADR-UMC Bridge was successfully implemented so that pricing information can now be sent to residential and commercial devices from a single interface. Generating an event on the DRAS brings up the screen shown in Figure 4, where the notification time, start time, duration of the event and price levels are chosen. The UMC server pulls the event information from the DRAS at one-minute intervals.

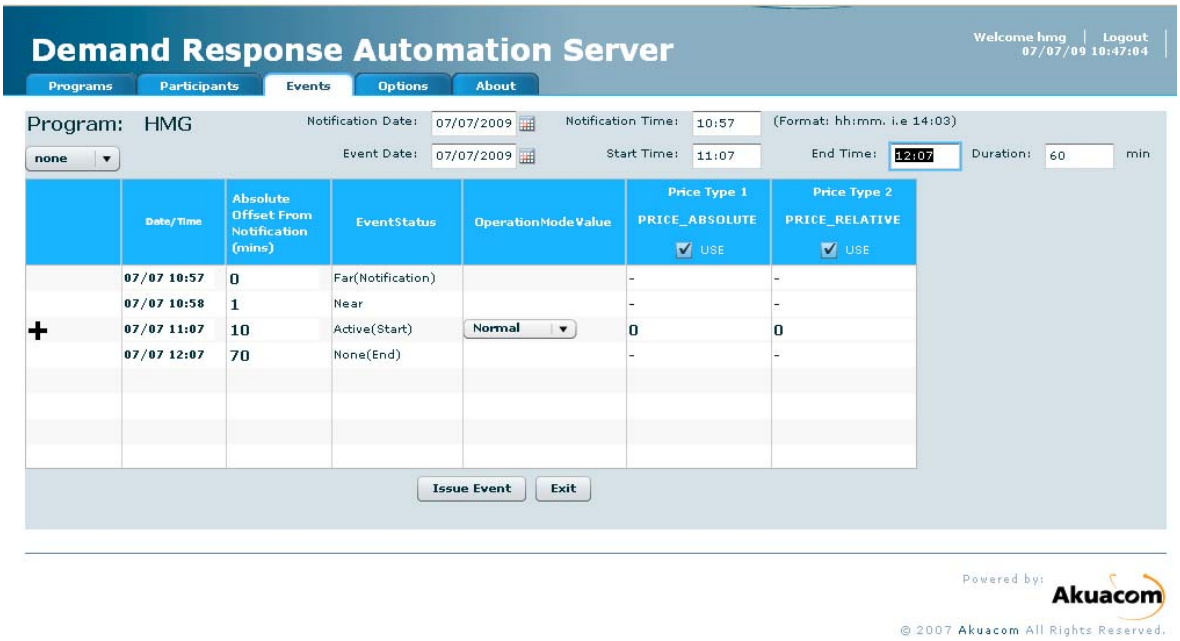

Figure 4. Web-based Interface to the Demand Response Automation Server (DRAS)

Figure 5 illustrates the integrated ADR-UMC communication system, which takes a price schedule, maps it to price tiers, and then sends out both sets of data over the Internet to OpenADR devices and to the UMC servers containing the ADR-UMC Bridge. The ADR-UMC Bridge then transforms the OpenADR signals into one or more RDS messages and broadcasts them over the FM airwaves using RDS transmission equipment that was installed at Sacramento's Capital Public Radio, or KXJZ 90.9 FM, for a previous study (Herter et al. 2008). KXJZ's antenna, broadcasting at 50,000 watts, is located north of downtown Sacramento at Latitude 38° 42' 38" N, Lon 121° 28' 54" W.

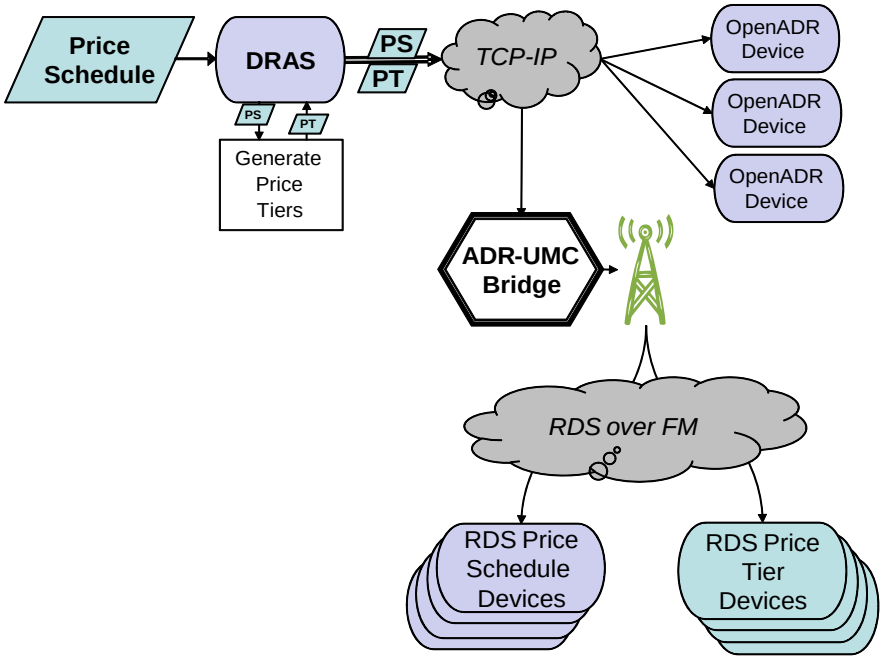

Figure 5: Overview of the OpenADR-UMC system

Although the demonstration unit responds to FM station broadcast, reception from the partnering FM station located in Sacramento is not a certainty, especially when the unit is out of range of this one station. To ensure reception at all times, a portable RDS radio transmitter was added to the display, to ensure that the demonstration unit can be operated anywhere in the United States on short notice. This local transmitter plugs into the netbook computer and receives signals from the UMC server via the Internet. UMC messages are then sent to devices located within approximately two feet of the RDS transmitter.

3.2. Sending Price Events

The demonstration unit has a netbook computer to send the initial OpenADR price signal. A special demonstration website was created for this project to allow viewers to send a pre-coded price schedule (Table 3) with a single button. This allows users to send a real OpenADR price schedule, which is translated to UMC price signals as described previously.

The ADR-UMC Bridge resides on the UMC server, which is set up as a client to the DRAS. It polls the DRAS every minute for events, and when an event is found, it checks to see if the event is already in the UMC system. If so, no action is taken. If not, it generates the new event and creates a new set of UMC messages based on the mapping in **Error! Reference source not found.**.

Table 3. Price schedule used for the demo

OpenADR	UMC	Price	Timing
Moderate	Tier 2	$0.11	2 minutes after event initiated
High	Tier 3	$0.15	4 minutes after event initiated
Normal	Tier 1	$0.08	6 minutes after event initiated

Three price tiers are currently enabled in the DRAS: normal, moderate and high. These price tiers map to UMC price tiers 1, 2, and 3, respectively (**Error! Reference source not found.**).[1] vent information is pulled by the UMC server whenever the notification time begins. Therefore to allow enough time for the UMC server to receive and send event messages, the notification time needs to be at least one minute before the start of an event.

3.3. Information and Control Devices

Five devices capable of responding to price events are incorporated into the demonstration display. One responds to signals sent using the OpenADR protocol, the other four respond to UMC signals sent via RDS. The following sections describe each of the devices in more detail.

3.3.1. Universal Devices ISY-99i Controller

The ISY-99i Home Automation Controller receives OpenADR signals and transmits the data to local INSTEON devices. In this demonstration, the ISY-99i sends data to several SmartHome INSTEON devices: the PowerLinc Modem, the LampLinc lamp dimmer module, and the ApplianceLinc module (Figure 6).

The ISY-99i allows creation of customer-defined programs that can dim plug loads, turn them off, and restore (full) power. For the demonstration display, a program was created that dimmed the lights to 30% and turned off the spa pump when the price of electricity was higher than $0.10 per kWh. The normal price was set at $0.08/kWh, so moderate and high price tiers triggered this event.

[1]Although AutoADR is capable of signaling a Tier 4 event, the DRAS did not allow it when this study was conducted.

Figure 6. ISY-99i Controller with SmartHome PowerLinc Modem, LampLinc and ApplianceLinc modules

Devices were readily linked to the ISY-99i Home Automation Controller following vendor instructions. Connecting the ISY-99i Home Automation Controller to the DRAS was more problematic. Phone calls with technical support revealed a firmware update was required. Once that was done, the DRAS's URL, client name, and password were entered and the device was able to receive price signals via OpenADR.

3.3.2. General Electric Demand Response Module

The GE demand response module is a controller designed to interface with any GE appliance that has demand response capabilities. GE's current UMC-ready product line includes a Home Energy Monitor, a clothes washer, clothes dryer, dishwasher, water heater, refrigerator, microwave, and range. These appliances all respond to Tier 4 events by reducing or delaying system functionality until after the event ends. In all cases, the customer can choose to override events.

Inside the casing is an RDS receiver for receiving the price signals sent over the UMC protocol. The front of the DR module has four (4) colored LEDs that light up according to the price signal received from the utility. Different appliances have different responses according the current price tier.

Figure 7. GE's DR module

In real life, all of GE's RDS-ready appliances are programmed to respond in slightly different ways when the GE demand response module signals to them that it has received a Tier 4 price signal. All appliances display a message to the customer informing them that an event is imminent (or in progress), and that services will be either reduced or delayed. The user can then override the event functionality for each appliance before or during the event. In the absence of

an event, these smart appliances can be programmed to provide services only during off-peak hours every day.

For example, on receiving a price signal, the default response for GE's smart laundry and dishwasher units is a delay until the event is over, while General Electric's smart refrigerator delays the just the defrost cycle and turns off the anti-sweat heaters until after the peak period ends. GE's smart hot water heater responds by using only one low-power heating element until after the peak period ends. Similarly, the smart range uses a reduced power setting until after the peak period ends, and the smart microwave uses 10% less power during events (Wall Street Journal 2009).

A full-sized GE appliance would not fit in the display, so the GE module is set up to control red LED lights representing heating elements in common household appliances: water heater, dryer, refrigerator anti-sweat heater, and oven. Digital signals were converted from GE's demand response module by decoding the output voltage sent over the Ethernet cable as an input to a hex inverter. The unit is configured to turn appliances off during price tiers 3 and 4.

3.3.3. EnergyHub

The EnergyHub device monitors plug-loads using a Wi-Fi connection between the dashboard display and the plug-load monitors. At the time of this project, the EnergyHub dashboard was not designed to receive price information. In this demonstration, the EnergyHub device is used to display the real-time load profile of the model appliances. EnergyHub provides a customizable device with no screen timeout making it suitable for the display.

Figure 8. EnergyHub dashboard and Plug-load monitor

3.3.4. Entek Load Switch

The Entek Load Switch is the only device in this display that uses a proprietary (non-UMC) protocol for signal transmission over RDS. For this demonstration, the Entek TC240 load control unit was fitted with an RDS receiver to allow the shedding of varying amounts of load at each price tier. For the Residential OpenADR Demonstration, the unit was programmed to shed 50% of the connected load when a Tier 3 price signal is received and 100% of the load when a Tier 4 price signal is received.

Figure 9. Entek TC240 Load Control Switch

3.3.5. RCS TE43 Thermostat

Residential Control Systems TE43 programmable thermostat is equipped with an RDS receiver. Reception of a price signal triggers a temperature setback of between zero and nine degrees, as determined by the end user. An option to pre-cool is also available. This thermostat can receive both absolute price and price tier information. The absolute price, when available through the UMC message, is presented on the LCD display, in addition to the notification that an event is in progress. For display purposes, the thermostat is wired to a computer processor fan and a blue LED meant to represent an air-conditioning unit. The fan and blue LED turn off on reception of a Tier 3 price signal.

3.4. Demonstration Unit

The Residential OpenADR Demonstration Unit was designed to be relatively portable, to allow the unit to be easily moved from place to place, as requested. When packed away, the unit measures roughly 36" wide by 30" deep by 42" high and rolls on four wheels, which can be locked for stability. The course of events involved in the initiation of the pricing event is detailed in Appendix A: Instructions for Residential OpenADR Demonstration.

The model home was built from a kit that provided the main wall and roof structure. Details, such as roofing shingles, windows, window trim, flooring, baseboard, wall texture and paint were added for realism. Appliances and lighting fixtures to be controlled were either purchased or created from available materials, while furniture was created to complete the effect. Close-up photographs of the rooms in the model home are provided in Figure 11, while the exterior of the home and close-up photographs of the hot tub and AC blower unit are shown in Figure 12.

Figure 10. The residential OpenADR demonstration unit

Figure 11. Interior of the residential Open-ADR model home

Figure 12. Exterior of the residential Open-ADR model home, with hot tub and air-conditioning unit

4.0 Conclusions and Recommendations

The Open Automated Demand Response standard is a flexible, open-standard information model that has been used since 2001 to send electricity pricing and event information to energy management control systems in large commercial and industrial buildings. Technically, this model can be used for residential applications; however, it requires Internet connectivity, which is not yet ubiquitous in the residential sector. To address this potential shortfall, this project was designed to broaden the reach of Open Automated Demand Response signals by providing a link to a communications technology that is nearly ubiquitous in all sectors: FM radio.

The objectives of this study were to:

1. Work with communications vendors to develop a software bridge from *Open Automated Demand Response*, an information model designed for two-way communications over the Internet, to the *Utility Message Channel*, an information model designed for one-way broadcast over FM radio.
2. Assemble a portable demonstration unit that can initiate a real price event via Internet and FM radio, receive the pricing signals across a variety of communicating control technologies, and model the potential response of residential appliances and lighting.

4.1. Conclusions

This study demonstrates demand response system that consists of two widely available and non-proprietary communications technologies capable of delivering electricity pricing and events signals to a variety of mass-market devices. The Open Automated Demand Response system and the Utility Message Channel system were successfully integrated such that electricity-pricing notifications can now be sent to groups of devices by the Internet and FM radio, simultaneously. A portable unit was constructed to demonstrate this capability.

4.2. Recommendations

The ADR-UMC system should be considered an option in all future utility plans for customer notification of electricity pricing, given its low-cost, wide broadcast range, open protocol, and support from the National Institute of Standards and Technology.

4.3. Benefits to California

The integrated ADR-UMC system is now a viable option for broadcasting hourly or sub-hourly pricing information. It has the potential to keep the costs of new electric pricing programs low, while offering a secure, non-proprietary system with near universal customer coverage.

5.0 References

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National Institute of Standards and Technology. 2009. Standards Identified for Inclusion in the Smart Grid Interoperability Standards Framework, Release 1.0.

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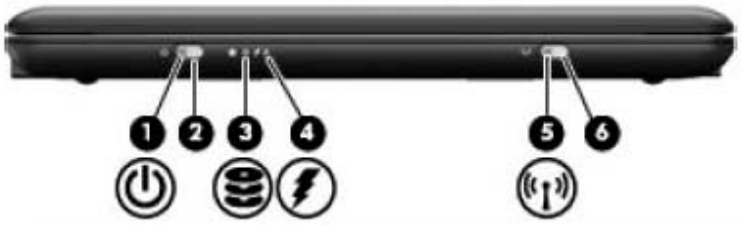
Appendix A: Instructions for Residential OpenADR Demonstration

1. **An Internet connection is required for this display to function.**
   A. Plug green Ethernet cable into wall port. Connects the Universal Devices ISY99i and netbook computer to the Internet (Devices "A" and "F" in Figure 20).
2. Plug Extension cord into wall outlet (provides power to all the devices).
3. **[Requires Philips-head screwdriver]** Unscrew the plastic cover on top of the computer. Power on netbook computer by lifting the front edge of the computer (which is secured with Velcro) and slide the power switch to the left (Component 2 in Figure 13). Ensure that the power cord, Ethernet cable and USB cord are firmly plugged in.



Component		Description
(1)	Power light	• On: The device is on. • Blinking: The device is in Suspend. • Off: The device is off.
(2)	Power switch	• When the device is off, slide the switch to the left to turn on the device. • When the device is on, briefly slide the switch to the left to initiate Hibernation. • When the device is in Suspend, briefly slide the switch to the left to exit Suspend. • When the device is in Hibernation, briefly slide the switch to the left to exit Hibernation. If the device has stopped responding and shutdown procedures are ineffective, slide and hold the power switch for at least 5 seconds to turn off the device. To learn more about your power settings, select **Settings** > **System** tab > **Power Management**.

Figure 13: From Quickstart Guide for HP Mini 1116NR

4. Once the computer boots up, make sure there is an active internet connection. If there is security on the local network, you may need to enter a password. If the local IT person requires the MAC addresses to allow access to the network, they are as follows:
   A. Netbook Ethernet MAC: 00-25-b3-49-28-47
   B. Netbook WiFi MAC: 00-25-56-44-24-98
   C. Universal Devices MAC: 00-21-b9-01-00-f5

5. Open application link “e-Radio Tx Server Client” located on the desktop. (Click to select it and press “Enter”).

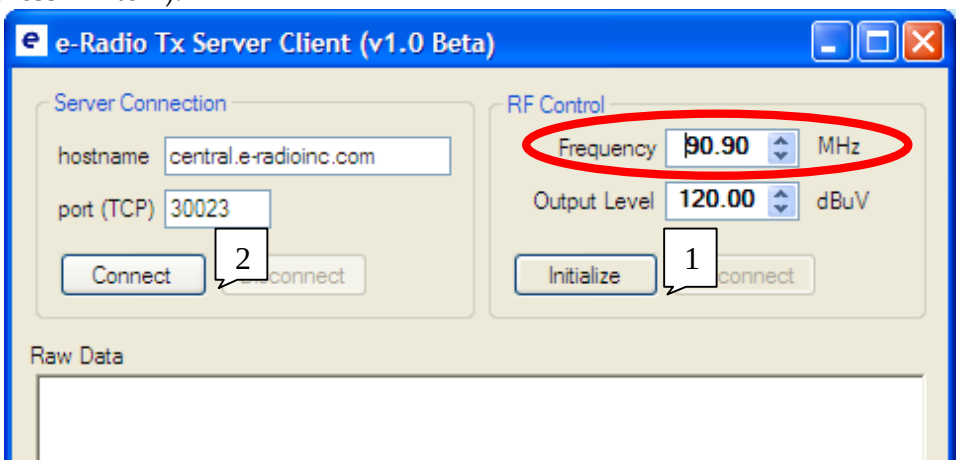


Figure 14: e-Radio Tx Server Client before connection

A. Set Frequency to 90.90 MHz (default is 88.50).
B. Click “Initialize” (1)
C. After board initializes “Tx board connected” will appear in the Raw Data field.

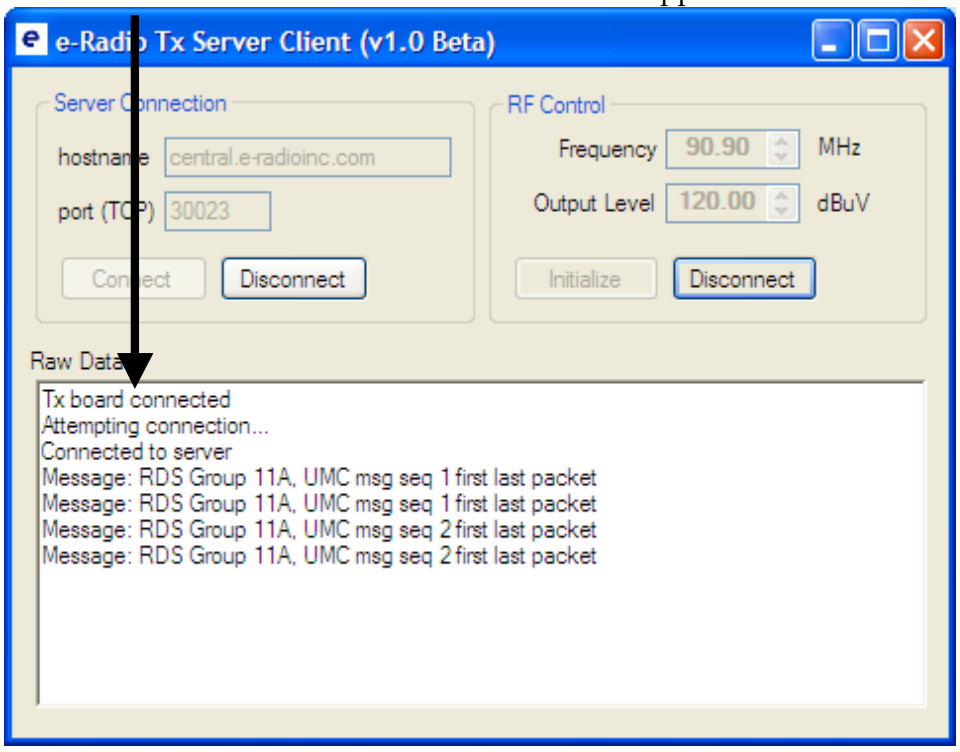


Figure 15: e-Radio Tx Server Client after connection

D. Click on “Connect” (2). It will read “Connected to server” and then begin to scroll messages as seen in the bottom four lines in Figure 15.

6. Open “Mozilla Firefox” (Shortcut on desktop, click to select and press “Enter”).

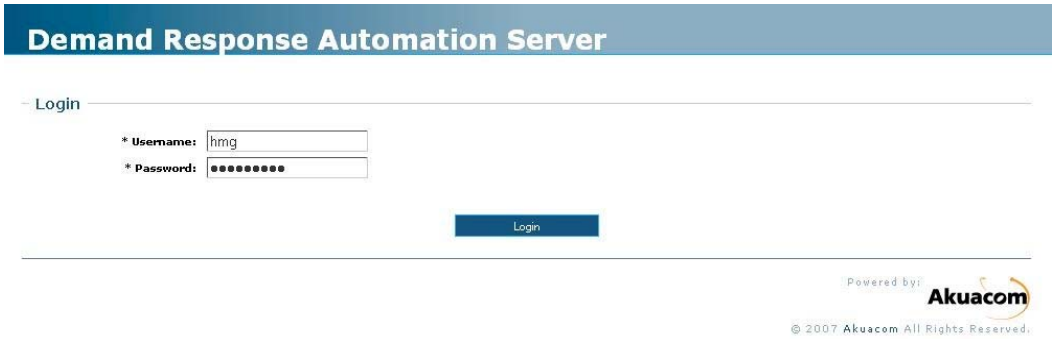


Figure 16: Login screen for DRAS

Homepage is set to the RDS DEMO page on the DRAS server. The HMG username and password are stored in the browser. Just click "login" to access the RDS DEMO page to create events. If there are any problems loading the page, click the home logo on the Firefox toolbar to reload the RDS DEMO page.

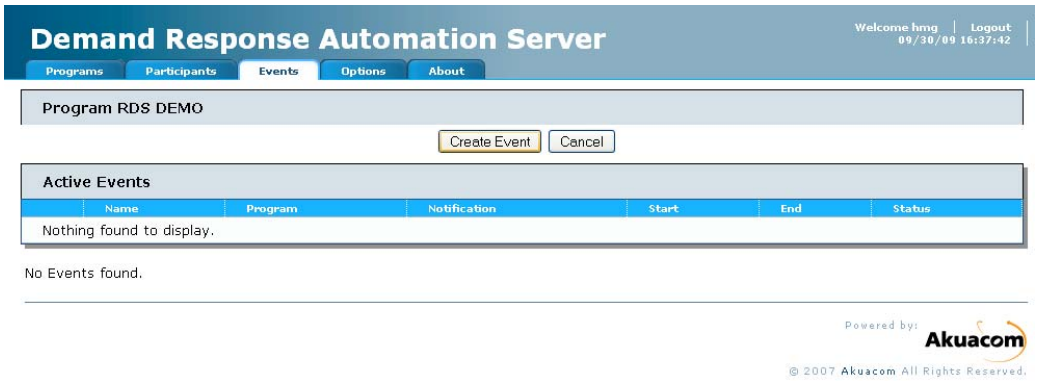


Figure 17: RDS Demo page: for creating events for Demo.

7. "Trigger Event and Slideshow.ahk" is a macro that upon clicking inside the DRAS – Firefox window will trigger an event and an informative PowerPoint slide show. This macro is in the Startup folder, and therefore activates when the computer first starts up.
   A. Clicking on "Create Event" adds an event to the "Active Events" queue.
   B. After two minutes, it will be a Tier 2 – Moderate Price event ($0.11). This will cause the lights in the house to dim, the spa pump to shut off, and the water heater lights to turn off and the dryer light to dim.
   C. After an additional two minutes, it will be a Tier 3 – High Price event ($0.15). This will cause the lights in the refrigerator, under the A/C unit, and the bottom LED in the oven to shut off in addition to the A/C fan and lights.
8. The spa on the side of the house is secured by Velcro. Disconnect the hose from the air pump and twist/pull up the spa to remove from display and fill it with water. Make sure the water line is just below the holes for the tubing. Replace when filled with water and reconnect tubing to air pump.

9. The thermostat needs to be set to a temperature at least one degree below the ambient air temperature. However, during the course of the display, the air temperature beneath the plexiglass will rise. In order for the demonstration to operate properly, the setpoint on the thermostat must be at least one, but less than nine degrees cooler than the air temperature being displayed. The default schedule is 73 degrees all the time. If the temperature needs to be adjusted, make the change and press the lower right hand button so that the screen reads "Hold".

Figure 18: RCS thermostat

10. The EnergyHub Display may show an error message at startup (Figure 19). If this is the case, you can wait for the screen to reset, or tap the "Force Close" button with a fingertip or closed pen. At the main screen double-tap the EnergyHub icon on the desktop when it loads. The touchscreen can be finicky, so please have patience.

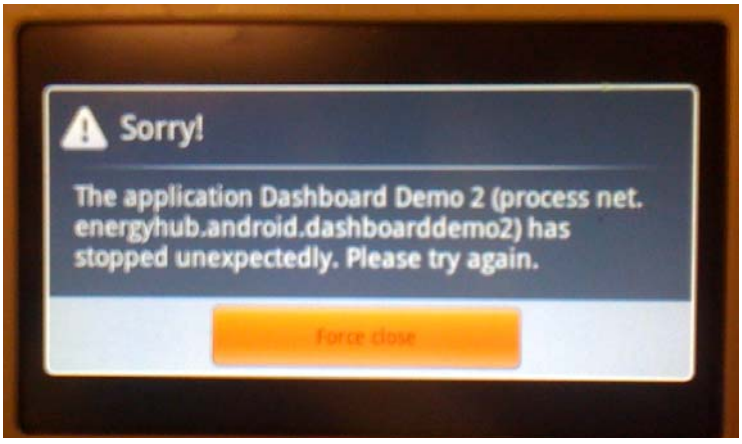


Figure 19: EnergyHub error message

11. If access to the Universal Devices controller is needed, open a web browser and type the following URL in the address bar: http://www.universal-devices.com/99i/
    A. Username and password are both: admin. This step should be unnecessary.

12. Troubleshooting:
    A. Make sure everything is plugged in and the power cords are switched "ON".
    B. If the Powerpoint slideshow does not begin with the initiation of an event, make sure the macro has been activated by double-clicking on the shortcut on the desktop titled: "Trigger Event and Slideshow.ahk"
    C. If you are unable to click on a program or button, try exiting the macro. You can do this by finding the green "H" logo in the taskbar, right-clicking on it and selecting "Exit". To run the macro again, double-click the "Trigger Event and Slideshow.ahk" shortcut on the desktop.
    D. For any complications NOT fixed by these guidelines or resetting the power, please contact Josh Rasin at rasin@h-m-g.com or (916) 962-7001.
13. The devices are shown in Figure 20: Device layout.
    A. Universal Devices OpenADR to INSTEON Controller
        i. Controls the spa pump, first floor lamps and second floor ceiling lights.
    B. Entek UMC Load Switch
        i. Controls the LED lights in the water heater and clothes dryer.
    C. General Electric UMC Router
        i. Controls the LED lights in the refrigerator and bottom oven light.
    D. Residential Control Systems UMC Thermostat
        i. Controls the "HVAC" compressor fan and LED lights beneath the fan.
    E. EnergyHub Display (Non-Communicating)
        i. Monitors the extension cord with all of the above devices' plug loads.
    F. HP Mini 1116NR – netbook computer
        i. Used to send the price schedule event to the DRAS.
        ii. Connects to the portable RDS transmitter beneath the computer shelf.

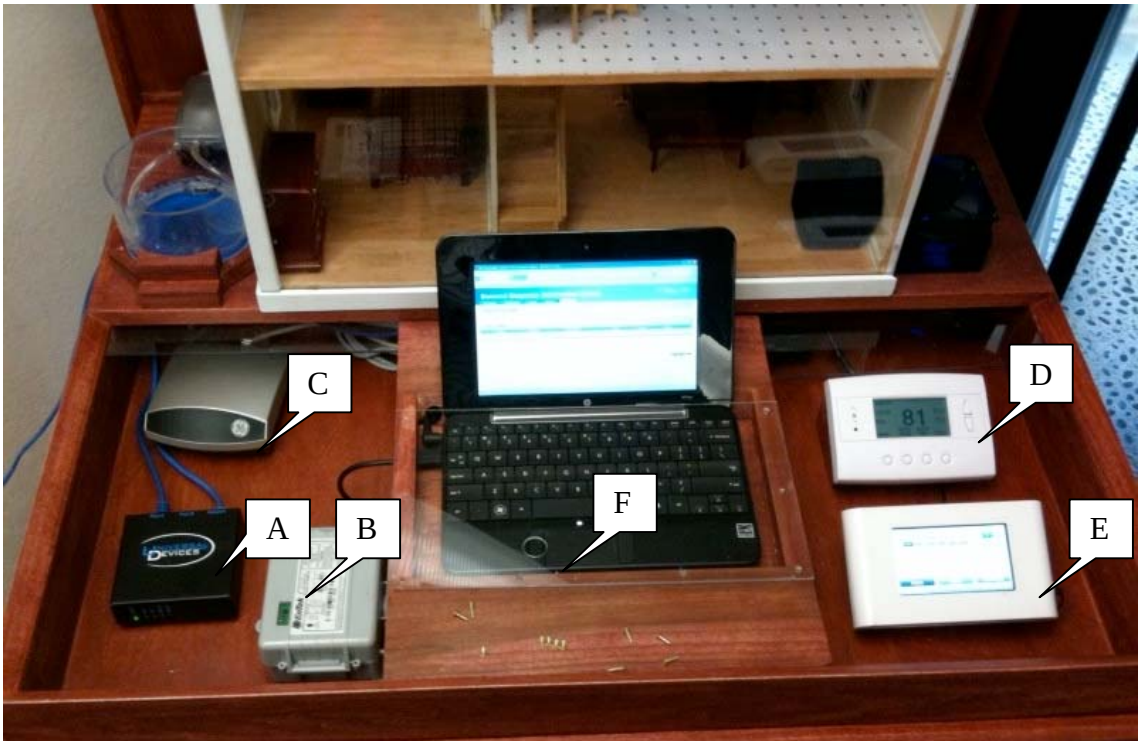


Figure 20: Device layout.