

# **OpenADR 2.0b Open Source Virtual Top Node – VTN User's Manual**

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**1026755**





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Technical Update, November 2014

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Nebland Software, LLC  
859 Richborough Rd  
Green Bay, WI

Principal Investigator  
B. DuPont

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# PRODUCT DESCRIPTION

The EPRI OpenADR 2.0b Virtual Top Node VTN server is an implementation of the OpenADR 2.0 Profile B specification. This application was designed to implement the role of a virtual top node (VTN) as defined in the OpenADR Alliance's *OpenADR 2.0 Profile Specification B Profile*, updated July 1, 2013. OpenADR is a machine-to-machine interface that defines the information model, transport and security mechanisms, and the manner in which data is exchanged between two endpoints. OpenADR 2.0 defines what and how information is communicated between an electricity service provider and customers, but it does not purport to define how either endpoint uses the information. This server application is one example of how the OpenADR 2.0 specification can be applied. It includes a graphical user interface used to set up user accounts, assign clients (Virtual End Nodes, or VENs), define resources and market contexts, and create and schedule demand response events.

This open-source application was developed to provide the electric power industry with an open-source research tool to demonstrate and test OpenADR 2.0. It provides utilities with a tool to research the potential use of OpenADR 2.0 in different use cases. The intent of making the source code available is to help expose any gaps in the OpenADR 2.0 specification that can only be identified through implementations.

EPRI's OpenADR VTN was developed and tested on an Ubuntu 12.04 desktop and server. Limited testing has been done on Mac OS X. The software has not been tested on Windows Server, though all of the software used to run the OpenADR VTN runs on Windows.

This manual describes VTN software version 9.3.

# REVISION HISTORY

January 2014	Initial Release
November 2014	Updated images to reflect UI changes Updated installation instructions Added the section <i>Set up and Configure Apache with SSL</i> General cleanup throughout



# ABSTRACT

The open-source OpenADR Virtual Top Node (VTN) application was developed to provide stakeholders with source code and an application that the industry could use to advance automated demand response research. The VTN was developed to conform to OpenADR 2.0 Profile B and has been certified by the OpenADR Alliance. It has a graphical user interface designed to set up user accounts, assign clients (Virtual End Nodes, or VENs), define resources and market contexts, and create and schedule demand response events. This user manual describes how to install and operate EPRI's open-source OpenADR VTN application.

## Keywords

Demand Response  
Automated Demand Response  
OpenADR 2.0b  
Profile B  
Virtual Top Node (VTN)  
Virtual End Node (VEN)



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# SOFTWARE INSTALLATION INFORMATION

## Installation of EPRI Software at Client Site

EPRI develops software using a number of third party software products and tools that run on various operating systems and server platforms. Reports from the software industry suggest there are known security issues with some products and systems. EPRI recommends that, if you are using EPRI software, you review its use with your Information Technology (IT) department and their overall strategy to ensure that all recommended security updates and patches are installed as needed in your corporation. If you have any concerns please call the EPRI Customer Assistance Center (CAC) at 1-800-313-3774 (or email [askepri@epri.com](mailto:askepri@epri.com)).

## If you experience difficulties accessing the application

If you experience difficulties accessing the application after standard installation on Windows XP, Windows Vista and Windows 7, please consult your IT department personnel to have proper access permissions setup for your use. If the problem can not be resolved, please call the EPRI Customer Assistance Center (CAC) at 1-800-313-3774 (or email [askepri@epri.com](mailto:askepri@epri.com)).



# 1

## GETTING STARTED

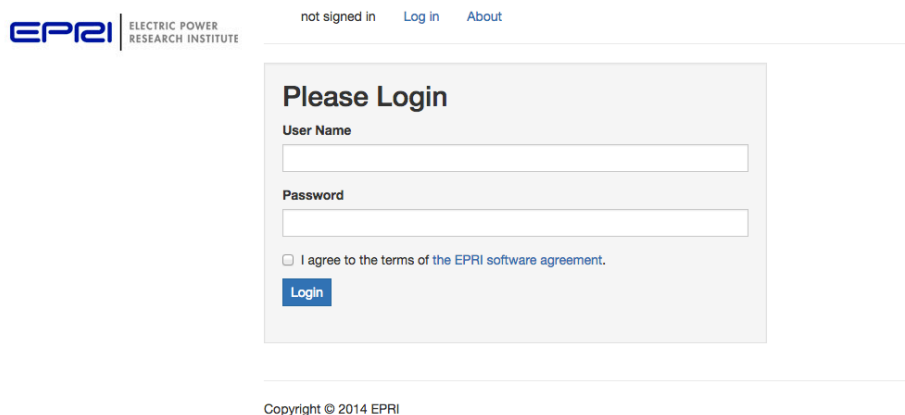
This manual assumes the user has access to an installed version of EPRI's OpenADR VTN server (VTN stands for *Virtual Top Node*). For installation instructions, see the *Installation* section at the end of this document.

This manual covers the functions of the web interface and is not intended to be a full description of the OpenADR protocol. This document demonstrates how VTNs and Virtual End Nodes (VENs) interact through the OpenADR protocol using EPRI's VEN and VTN software.

The VTN web user interface (UI) has been tested with Firefox on Linux, Microsoft Windows, and OS X; with Internet Explorer 10 on Microsoft Windows 7; and with Safari on OS X.

### Logging into the Server

The login screen is shown in Figure 1-1.



The screenshot shows the EPRI web login interface. At the top left is the EPRI logo with the text "ELECTRIC POWER RESEARCH INSTITUTE". To the right of the logo are links: "not signed in", "Log in", and "About". The main content area is a light gray box titled "Please Login". Inside this box are two input fields: "User Name" and "Password". Below the password field is a checkbox labeled "I agree to the terms of the EPRI software agreement." and a blue "Login" button. At the bottom of the page, below the login box, is the text "Copyright © 2014 EPRI".

**Figure 1-1**  
**The login screen**

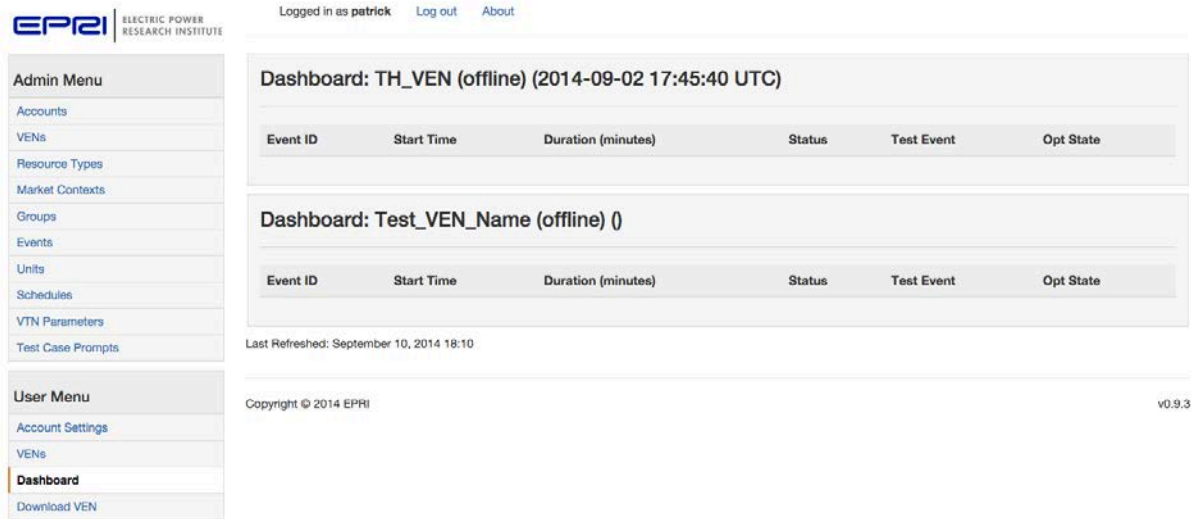
If you are accessing the server from a fresh install, login as the default admin user:

User Name: admin

Password: testing

If you are logging into EPRI's server, your EPRI representative will supply you with a user name and password.

Once logged into the server, you will be redirected to the dashboard. The dashboard shows which VENs are configured for the logged-in user and what events target those VENs. Figure 1-2 shows a dashboard with two VENs ("Test\_VEN\_Name" and "TH\_VEN") and neither VEN has an event associated with it.

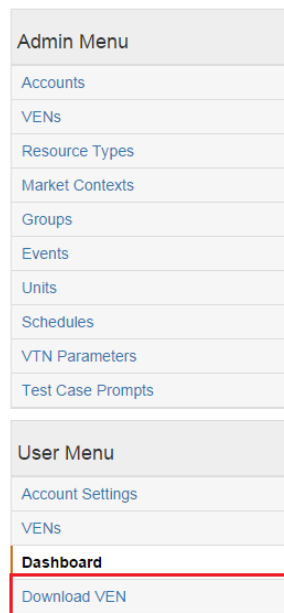


**Figure 1-2**  
**The dashboard**

Non-admin users will see the User Menu only. Admin users will see both the Admin Menu and the User Menu.

## Download the VEN

The User Menu contains a Download VEN link (see Figure 1-3). The software included in this download is a certified implementation of an OpenADR 2.0b VEN. This software can be used to test against the EPRI VTN or any compliant VTN implementation.



**Figure 1-3**  
**The Download VEN link**



## **A Note on Accounts and VENs**

The EPRI OpenADR VTN treats an account as a high-level entity that is used to manage any number of VENs. Non-admin accounts can create any number of VENs (but for their account only). Admin accounts can create VENs for any account.



# 2

## CONFIGURING THE SERVER

The main purpose of a VTN is to schedule and manage events for demand response programs. In OpenADR, the three main entities involved are VTNs, Events, and VENs. The VTN is the main application that supplies Events to a VEN. All of the configuration options covered below are intended to support sending Events to VENs.

The Admin Menu consists of the following options: Accounts, VENs, Resource Types, Market Contexts, Groups, Events, Schedules, VTN Parameters, and Test Case Prompts. Each of these options is covered below.

### Accounts

Clicking on the Accounts link brings up the account list page. From this page the user can edit or view the details of an account, destroy an account, create a new account, or add a VEN to an account.



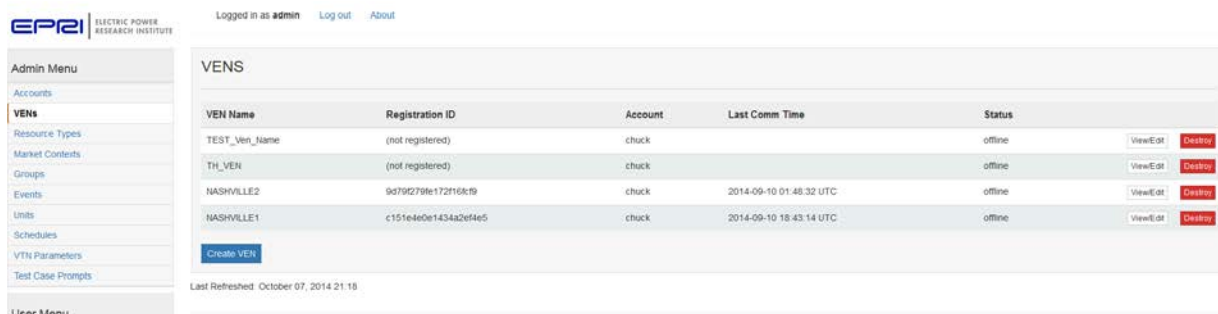
User Name	Email	Company	Administrator	
brian			true	<a href="#">EditView</a> <a href="#">Create VEN</a> <a href="#">Destroy</a>
gerald			true	<a href="#">EditView</a> <a href="#">Create VEN</a> <a href="#">Destroy</a>
admin			true	<a href="#">EditView</a> <a href="#">Create VEN</a> <a href="#">Destroy</a>
dmacville			true	<a href="#">EditView</a> <a href="#">Create VEN</a> <a href="#">Destroy</a>
patrick			true	<a href="#">EditView</a> <a href="#">Create VEN</a> <a href="#">Destroy</a>
chuck			true	<a href="#">EditView</a> <a href="#">Create VEN</a> <a href="#">Destroy</a>

[Create Account](#)

**Figure 2-1**  
The Account List page

### VENs

Clicking the VENs link brings up the VEN list page. From this page the user can view or edit a VEN, destroy a VEN, or create a new VEN.



VEN Name	Registration ID	Account	Last Comm Time	Status	
TEST_Ven_Name	(not registered)	chuck		offline	<a href="#">ViewEdit</a> <a href="#">Destroy</a>
TH_VEN	(not registered)	chuck		offline	<a href="#">ViewEdit</a> <a href="#">Destroy</a>
NASHVILLE2	9d79d279fe172f168f9	chuck	2014-09-10 01:48:32 UTC	offline	<a href="#">ViewEdit</a> <a href="#">Destroy</a>
NASHVILLE1	c151e4e0e1434a2ef4e5	chuck	2014-09-10 18:43:14 UTC	offline	<a href="#">ViewEdit</a> <a href="#">Destroy</a>

[Create VEN](#)

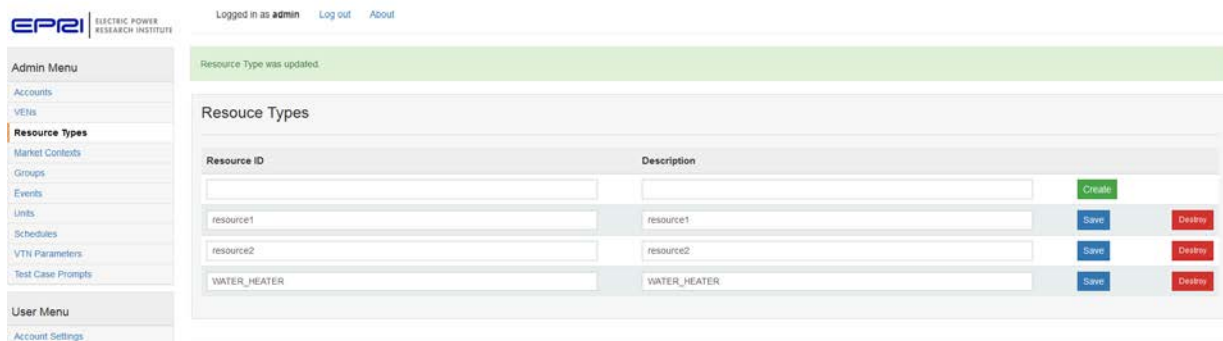
Last Refreshed: October 07, 2014 21:18

**Figure 2-2**  
The VEN List page

## Resource Types

From the Resource Types page the user can add and remove resource types. From the VEN edit/view page (covered under Configuring/Managing VENs), a user can add a resource to a VEN and assign a particular resource type to the resource. When scheduling an event, the user can target specific resource types. Any VEN with a resource associated with the selected target resource type will receive the event.

For example, an admin user can create a WATER\_HEATER resource type and associate the WATER\_HEATER resource with a set of VENs. The admin user can then create an event that targets VENs with a WATER\_HEATER by selecting WATER\_HEATER as a target resource.



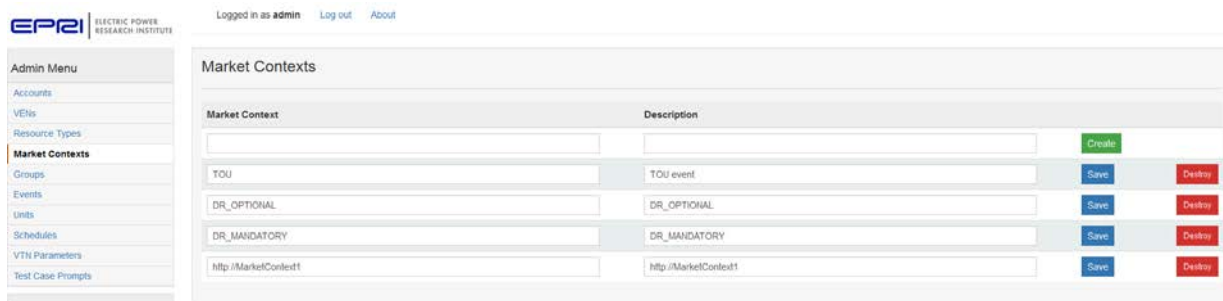
**Figure 2-3**  
The Resource Types List

## Market Contexts

*Market Context* is the OpenADR term for demand response programs. The Market Context items defined on this page can be assigned to an event through a dropdown list on each event's view/edit page.

VENs can subscribe or unsubscribe to/from a Market Context from the VEN view/edit page. Subscribing to a Market Context assigns a unique party ID to the VEN and allows an event to target that party ID.

The OpenADR protocol does not define how details of a demand response program are exchanged between a VTN and VEN. All that can be configured for a Market Context is a name (intended to be a URL) and a description. The description is informational only and is not used by the protocol.



**Figure 2-4**  
The Market Contexts list

## Groups

Admin users can create groups of VENs from the Groups page. The name of the group is arbitrary. By placing VENs into groups, an event can target multiple VENs by selecting the group as a target.

Groups in EPRI's OADR VTN are based on accounts. Because a single account can have multiple VENs associated with it, adding an account to a group effectively adds all VENs in the account to the selected group.

A group can be created by entering a unique name and a description, and then clicking the create button.

Group membership can be modified by clicking the Edit button next to the group. After clicking edit, a list of members and non-members will appear below the list of groups. To remove members from a group, select the checkbox next to the accounts that should be removed and click the Remove Accounts button. To add accounts, select the checkbox for the accounts to add and click Add Accounts. See Figure 2-5.

The screenshot displays the EPRI Groups management interface. On the left is a navigation menu with sections for Admin Menu (Accounts, VENs, Resource Types, Market Contexts, Groups, Events, Units, Schedules, VTN Parameters, Test Case Prompts) and User Menu (Account Settings, VENs, Dashboard, Download VEN). The main content area is titled 'Groups' and includes a 'Create' button. Below this, a table shows a group named 'GROUP1' with an 'Edit' button. The 'GROUP1 membership' section lists accounts with checkboxes for selection. A 'Remove Accounts' button is present above the list. At the bottom, an 'Add Accounts' button is visible.

**Figure 2-5**  
**Editing Group Membership**

## Events

From the Events List page the user can view/edit and destroy existing events or create a new event. See Figure 2-6.

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Logged in as **patrick** [Log out](#) [About](#)

**Admin Menu**

- Accounts
- VENS
- Resource Types
- Market Contexts
- Groups
- Events**
- Units
- Schedules
- VTN Parameters
- Test Case Prompts

**Events**

Event ID	Start Time	Priority	Status	Market Context ID	Test Event
314640ca824cb5625ab8	2014-09-10 18:24:17 UTC	0	completed	http://MarketContext1	false

[View/Edit](#) [Destroy](#)

[Create Event](#)

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**Figure 2-6**  
**The Events list**

See *Creating an Event* for more information.

## Schedules

The Schedules link shows a list of schedules. The user can view/edit or destroy existing schedules or create a new schedule from this page.

Schedules are used to create recurring events. A schedule has all of the same properties as an event, with the addition of the schedule properties. The schedule determines on what days of the week the event will be created. See Figure 2-7.

After an event is created from a schedule, the event will appear in the list of events and can be edited like any other event. See Figure 2-6.

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Logged in as **patrick** [Log out](#) [About](#)

**Admin Menu**

- Accounts
- VENS
- Resource Types
- Market Contexts
- Groups
- Events
- Units
- Schedules
- VTN Parameters
- Test Case Prompts

**User Menu**

- Account Settings
- VENS
- Dashboard
- Download VEN

**Schedule** [Settings](#) [Response](#) [Signals](#) [Targets](#)

**Schedule Duration and Event Start Time**

**Start Date**  
2014-08-07

**End Date**  
2014-09-01

**Start Time**  
09:00

[Save](#)

**Weekdays**

**Monday**  
☒

**Tuesday**  
☒

**Figure 2-7**  
**Editing a Schedule**

Because editing the other properties of a schedule is identical to modifying an event, readers should refer to *Creating an Event* for information on editing other properties of a schedule.

## **VTN Parameters**

The VTN Parameters page contains three sections: VTN Parameters, End Points, and Test VEN. See Figure 2-8.

### ***VTN Parameters***

A VTN has two parameters that can be set:

**VTN ID:** ID used to identify this VTN. Once the ID is set and VENs have been registered, the ID should not be changed.

**Poll Interval:** Minimum poll time. Poll VENs should poll the VTN at this interval.

Profile B VENs receive these values as part of the registration process.

### ***End Points***

The URLs under End Points provide example service URLs that VENs will use to communicate with the server.

### ***Test VEN***

The Test VEN section provides a dropdown list of VENs that are configured in the system. The VEN selected on this page will be used for testing with the QualityLogic test set. Events created under the Test Case Prompts link will be created for the VEN that is selected here.

Be sure to select a VEN that can be used for testing. With each new test case, all previous events for the VEN are removed from the system.

The screenshot shows the EPRI VTN Parameters web application. At the top, the EPRI logo and 'ELECTRIC POWER RESEARCH INSTITUTE' are on the left. The top right shows 'Logged in as patrick' with links for 'Log out' and 'About'. A left sidebar contains two menu sections: 'Admin Menu' with items like Accounts, VENs, Resource Types, Market Contexts, Groups, Events, Units, Schedules, VTN Parameters (highlighted), and Test Case Prompts; and 'User Menu' with Account Settings, VENs, Dashboard, and Download VEN. The main content area is divided into three sections: 'VTN Parameters' with input fields for 'VTN ID' (EPRI\_VTN) and 'Poll Interval (seconds)' (10), an 'Update Parameters' button, and an 'End Points' section with 'Profile 2.0a Path' and 'Profile 2.0b Path' text boxes; 'Test VEN' with a 'VEN Name' dropdown menu set to 'DemoCase' and an 'Update Test VEN' button.

**Figure 2-8**  
VTN parameters

## Test Case Prompts

Test case prompts aid in testing the VTN with the QualityLogic test harness event tests. If the prompts were not loaded during installation, only the Prompt Filter will be visible. See Figure 2-9. See the *Set up the Application* section of the installation instructions for information on how to load the test prompts.

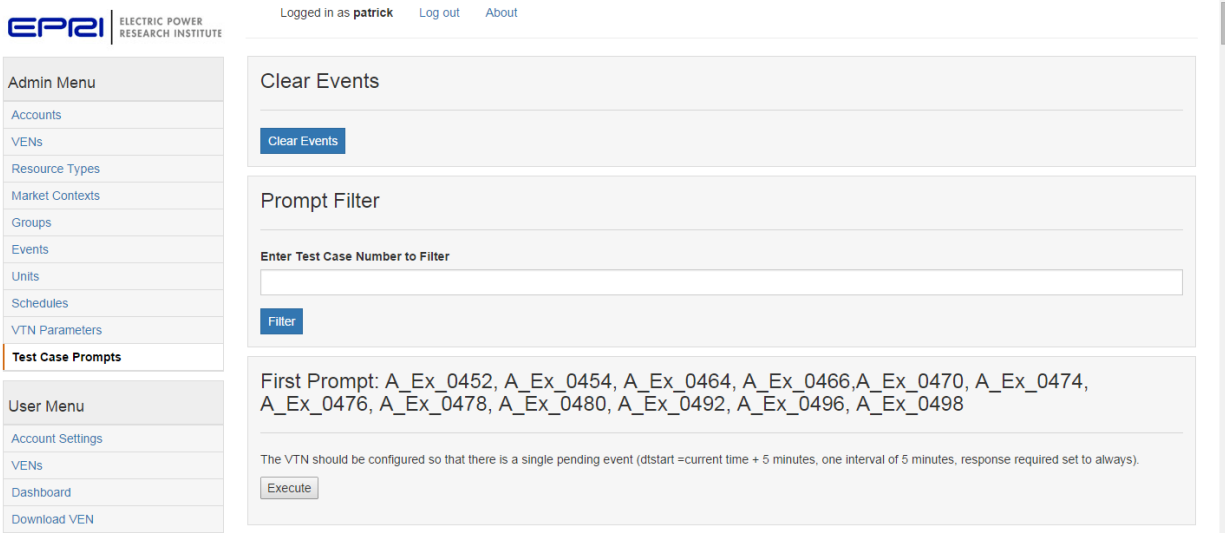
The screenshot shows the EPRI Test Case Prompts web application. The top navigation and sidebar are identical to Figure 2-8. In the sidebar, 'Test Case Prompts' is highlighted. The main content area has two sections: 'Clear Events' with a 'Clear Events' button, and 'Prompt Filter' which includes the text 'Enter Test Case Number to Filter' above a text input field and a 'Filter' button.

**Figure 2-9**  
The test case prompts view if no prompts were loaded

If the prompts have been loaded, the screen will look like Figure 2-10. For brevity, only the first prompt is shown in the image.

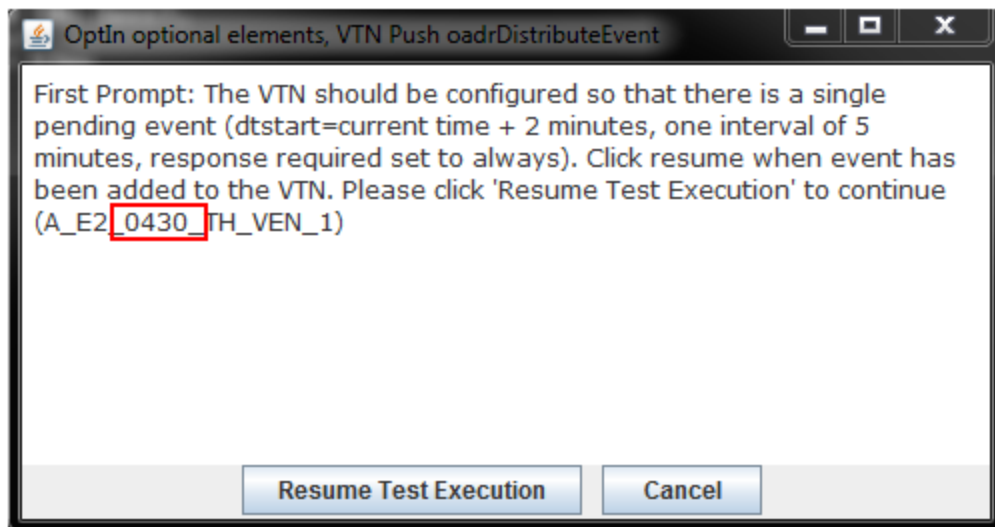


The filter at the top of the Test Case Prompts page can be used to quickly find a test case prompt to execute. Simply type the test case number into the filter and click the Filter button. Test case prompt numbers can be retrieved from the QualityLogic test case prompts. See Figure 2-11.



**Figure 2-10**  
Test case prompts view when the prompts have been loaded

Figure 2-11 shows a sample prompt from the test harness (the user would type 0430 into the filter to find the test case prompt(s) to execute in the EPRI OpenADR VTN). See *Running Test Cases against the Test Set* for more information.



**Figure 2-11**  
Example prompt from the test harness



# 3

## CONFIGURING AND MANAGING VENS

The tabs on the VEN view/edit page are described below.

### VEN Settings

VEN Settings contains sections covering Identification, OpenADR Profile Settings, Capabilities, and VEN location. See Figure 3-1.

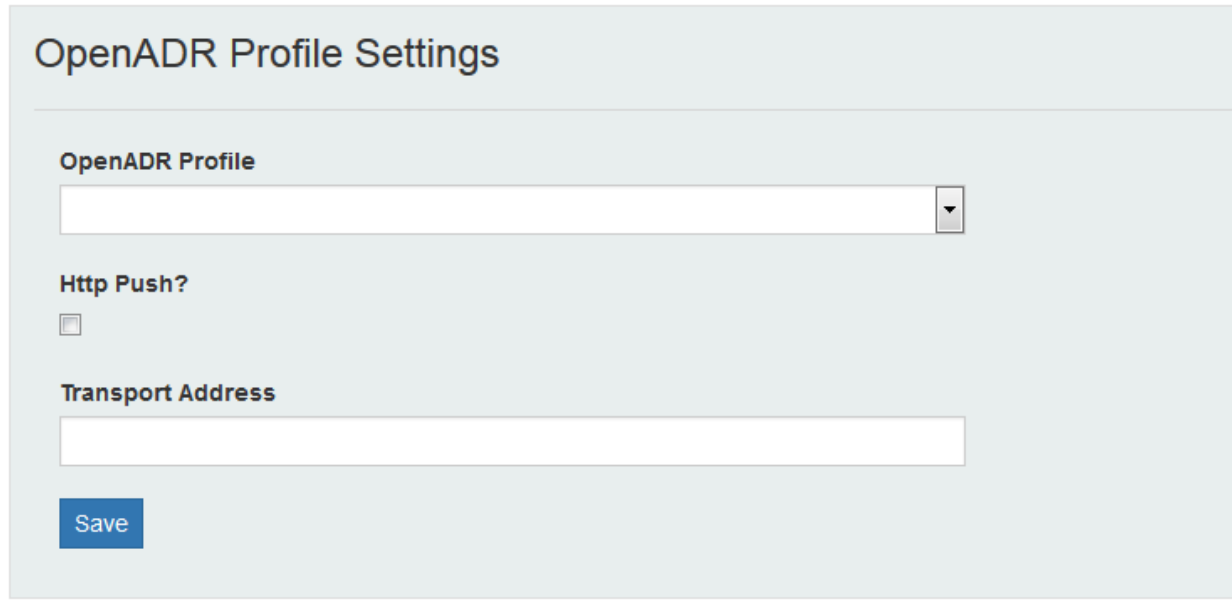
The screenshot displays the 'VEN Settings' page with a navigation bar at the top containing tabs: 'VEN Settings', 'Registrations', 'Resources', 'Subscriptions', 'Reports', and 'Opt Schedules'. The 'VEN Settings' tab is active. Below the navigation bar, the 'Identification' section contains the following fields: 'VEN Name' (text input with value 'TH\_VEN'), 'Common Name' (text input with value 'TH\_VEN'), 'VEN ID' (text input with value 'b5f74feb5a3d4640f1b9'), 'Email' (empty text input), and 'Account' (text input with value 'patrick'). A blue 'Save' button is located below the 'Account' field. Below the 'Identification' section is the 'OpenADR Profile Settings' section, which contains an 'OpenADR Profile' dropdown menu.

**Figure 3-1**  
**VEN Settings**

The identification parameters uniquely identify a VEN. The VEN name is a human-readable string that is assigned to the VEN. When a VEN registers with a VTN, the VEN will present its VEN Name or VEN ID. The VTN validates the SSL common name and sends the VEN ID in response. After registering, the VEN will use its VEN ID in all communications with the server.

The Common Name field is only used when communicating over SSL. When SSL is used, the VTN will validate that the common name found in the VEN certificate matches the common name configured in the database. The combination of a common name and a VEN ID should be unique, meaning that an SSL certificate is assigned to a particular VEN and not shared among multiple VENS.

Under the OpenADR Profile Settings section, the user can select the OpenADR Profile, whether or not the VEN is a push VEN, and set the transport address. These settings are only needed for Profile A VENS since Profile A does not have a registration service.



**OpenADR Profile Settings**

**OpenADR Profile**

**Http Push?**

☐

**Transport Address**

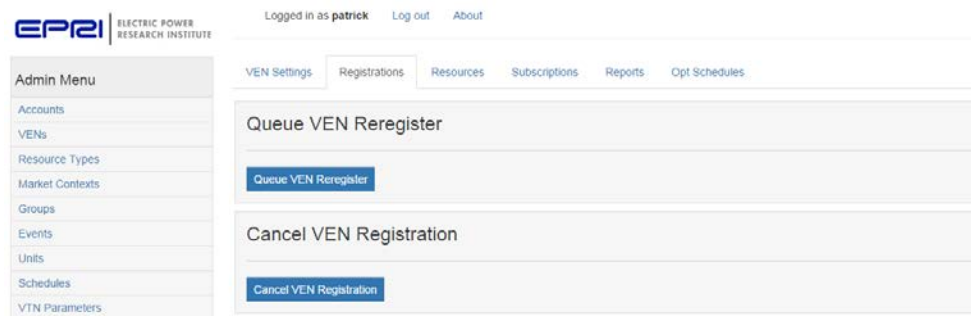
**Save**

**Figure 3-2**  
**The OpenADR Profile Settings used when configuring Profile 2.0a VENs**

The Capabilities and VEN Location parameters are currently not used by the system.

## Registrations

The top of the page contains the following buttons: Queue VEN Reregister, Cancel VEN Registration, and Clear VEN Registration. See Figure 3-3.



EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Logged in as **patrick** | Log out | About

VEN Settings | **Registrations** | Resources | Subscriptions | Reports | Opt Schedules

**Admin Menu**

- Accounts
- VENs
- Resource Types
- Market Contexts
- Groups
- Events
- Units
- Schedules
- VTN Parameters

**Queue VEN Reregister**

**Queue VEN Reregister**

**Cancel VEN Registration**

**Cancel VEN Registration**

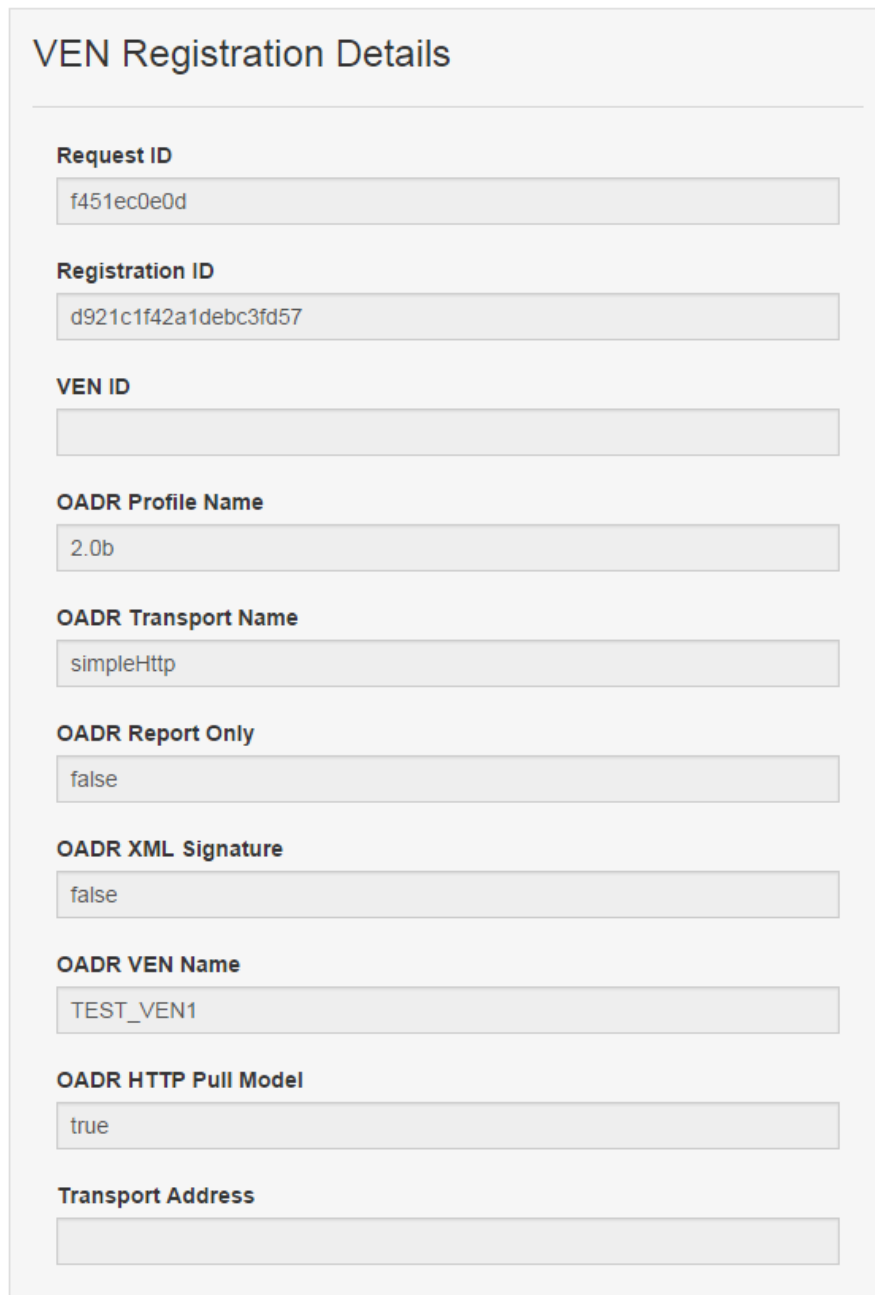
**Figure 3-3**  
**Reregister and cancel registration**

The first button will queue a reregistration message for poll VENs or push a reregistration message for push VENs. This message forces a VEN to go through the registration process again. If VTN registration information is changed, this feature can be used to force the VEN to reregister in order to receive the updated information.

The second button queues a cancel registration message for poll VENs and pushes a cancel registration message for push VENs. It is unclear how this exchange should be used by the VTN. If a VEN has a valid SSL certificate and the VEN has an entry in the EPRI VTN, the VEN will be able to reregister. Canceling a registration does not block the VEN from communicating with the server.

The Clear VEN Registration button will clear the registration locally but not notify the VEN.

The final section of this tab contains the registration details. If a VEN is not registered, there will be no information in the VEN Registration Details box. See Figure 3-4.



The image shows a web form titled "VEN Registration Details". It contains several input fields, each with a label above it. The fields are: Request ID (value: f451ec0e0d), Registration ID (value: d921c1f42a1debc3fd57), VEN ID (empty), OADR Profile Name (value: 2.0b), OADR Transport Name (value: simpleHttp), OADR Report Only (value: false), OADR XML Signature (value: false), OADR VEN Name (value: TEST\_VEN1), OADR HTTP Pull Model (value: true), and Transport Address (empty).

Field Label	Value
Request ID	f451ec0e0d
Registration ID	d921c1f42a1debc3fd57
VEN ID	
OADR Profile Name	2.0b
OADR Transport Name	simpleHttp
OADR Report Only	false
OADR XML Signature	false
OADR VEN Name	TEST_VEN1
OADR HTTP Pull Model	true
Transport Address	

**Figure 3-4**  
**VEN Registration Details**

## Resources

The VEN Resources tab shows a list of resources that are associated with the VEN.

In Profile 2.0b, a VTN can target certain resources in an event or a signal in an event can target certain resources, and a VTN can request reports for resources. From this list, the user can view/edit or destroy a resource or add a resource to the VEN. See Figure 3-5.

VEN Settings Registrations **Resources** Subscriptions Reports Opt Schedules

### VEN Resources

Name	Resource ID	Address	Shed Capability	Ramp Period	Recovery Period
Test_Resource	resource1				

View/Edit Destroy

Add Resource

**Figure 3-5**  
**VEN Resources list**

Clicking the view/edit link brings up the view/edit page for a resource. See Figure 3-6. The Resource ID can be used to target VENs with a certain resource type. The name of the resource is to help the VEN administrator identify the resource.

The other fields are not used by the system at this time, but they could be used to determine the impact of an event. Additionally, the location fields could be used to group VENs by location.

### Resource Identification

Name: Test\_Resource VEN: TH\_VEN Resource ID: resource1

Update Identification

### Location

Address: State: TN Zip: Geospatial Location: Grid Electrical Coordinates:

Update Identification

### Capabilities

Shed Capability: Ramp Period: Recovery Period:

Update Capabilities

**Figure 3-6**  
**Resource edit**

Clicking the Add Resource button (see Figure 3-5) brings up the display shown in Figure 3-7. A VEN can have any number of resources.

Create Resource for VEN TH\_VEN

Name	VEN	Address
<input type="text"/>	TH_VEN	<input type="text"/>
State	Zip	Resource ID
<input type="text"/>	<input type="text"/>	resource1

Create Resource

Back to VEN TH\_VEN

**Figure 3-7**  
**New Resource**

## Subscriptions

The Market Context Subscriptions list shows which market contexts the VEN is subscribed to (see Figure 3-8). In Figure 3-8, the VEN is subscribed to context “TOU” and not subscribed to the other contexts on the list. The user can subscribe or unsubscribe by pressing the associated button.

Market Context	Party ID	
TOU	TEST_Ven_Name.TOU	Unsubscribe
DR_OPTIONAL		Subscribe
DR_MANDATORY		Subscribe
http://MarketContext1		Subscribe

**Figure 3-8**  
**Market Context Subscriptions**

When subscribed to a market, the VEN is assigned a unique Party ID, which is a combination of the VEN Name and the Market Context ID. This Party ID can be selected by the admin user when selecting Party ID targets (see *Creating an Event*).<sup>1</sup>

## Reports

The Reports list consists of reports that the VEN registered during the registration process.

---

<sup>1</sup> This is probably not how the Alliance envisioned using Party ID. When a VEN subscribes to a Market Context, that VEN should automatically receive events that are created in that Market Context. In other words, the admin user creating an event should not have to manually select specific party IDs. There are also other implications to consider. For example, is a party ID something that should be kept private? In other words, when party IDs are added to an event, should every VEN that receives the event see every party ID?

[VEN Settings](#) [Registrations](#) [Resources](#) [Subscriptions](#) [Reports](#) [Opt Schedules](#)

### Reports

Specfier ID	Created Date/Time	Duration	Report Name		
789ed6cd4e_telemetry_status	2014-09-02 17:43:13 UTC	PT2H	METADATA_TELEMETRY_STATUS	<a href="#">View/Edit</a>	<a href="#">Destroy</a>
789ed6cd4e_telemetry_usage	2014-09-02 17:43:13 UTC	PT2H	METADATA_TELEMETRY_USAGE	<a href="#">View/Edit</a>	<a href="#">Destroy</a>
789ed6cd4e_history_usage	2014-09-02 17:43:13 UTC	PT2H	METADATA_HISTORY_USAGE	<a href="#">View/Edit</a>	<a href="#">Destroy</a>

### Report Requests

Name	Description	Request ID	Active
------	-------------	------------	--------

[Create Report Request](#)

**Figure 3-9**  
**The Reports list**

The view/edit screen shows the details of a report, including a description of the report intervals and the most recent values for each interval as reported by the VEN. See Figure 3-10.

The report view page has three sections: Report Identification, Report Description, and Report Instance.

### ***Report Identification***

The Report Identification fields show the type of report (telemetry or history), duration, and the date and time when the report was created (as reported in the Open ADR message).

### ***Report Description***

The Report Description section shows what intervals are available in the report.

### ***Report Instance***

Report instances are actual data reports. While a report description describes the data points (or intervals) in a report, report instances report data values. The Report Instance section shows a list of the five most recent reports.



### Report Identification

**VEN**

**Report Name**

**Specifier ID**

**Duration**

**Created Date/Time**

### Report Description

rid	Reading Type	EMIX	Data Source	Max Sample Period	Min Sample Period	Sample on Change
resource1_status	x-notApplicable		resource1	PT1M	PT1M	false

### Intervals (resource1\_status)

Start Date/Time	Online	Manual Override	Data Quality	uid
-----------------	--------	-----------------	--------------	-----

**Figure 3-10**  
**Report view**

## Report Requests

The VTN can request that the VEN report on any interval from any registered report by creating a Report Request. Figure 3-11 shows an example list of Report Requests.

### Report Requests

Name	Description	Request ID	Active
Test_Request	For testing	6ed8462c1b39f46799a7	<input type="button" value="View/Edit"/> <input type="button" value="Destroy"/>

**Figure 3-11**  
**The Report Requests list**

If a report request is active, the request has been sent to the VEN, causing the VEN to send the report to the VTN at the interval requested in the report request.

The following three sections describe how to create and edit requests, how to send requests to a VEN, and how to cancel requests.

### Create Report Request

Clicking the Create Request Report button opens the new Request Report screen. See Figure 3-12.



**Figure 3-12**  
**New Report Request**

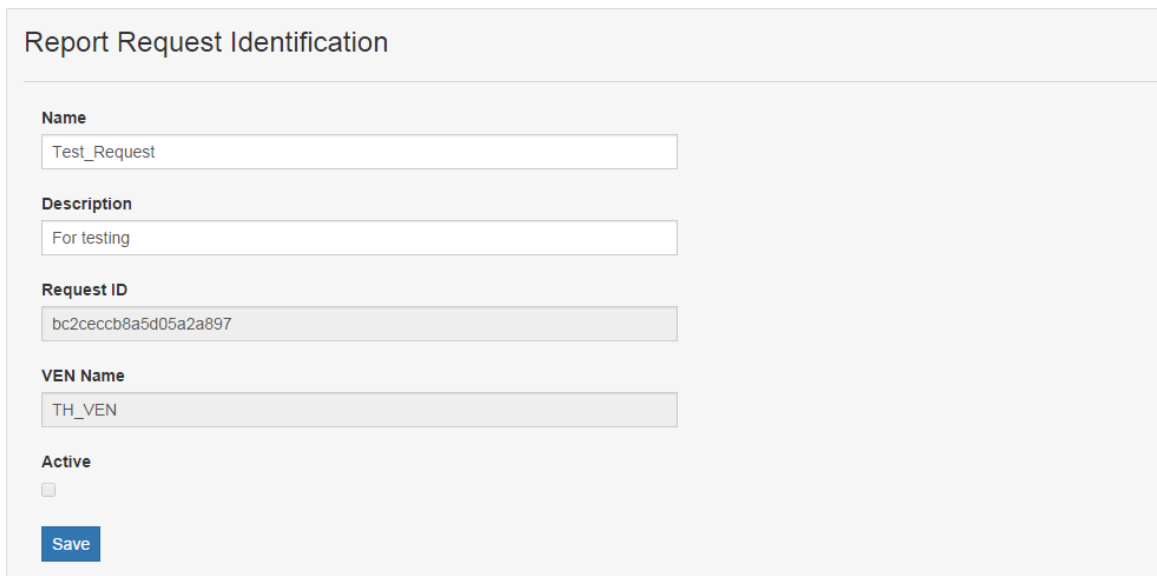
To create a new request, click the Create Report Request button in the Report Requests list (see Figure 3-10). The new Report Request screen is displayed. See Figure 3-12.

Both the name and description fields are informational only, to aid in identifying report requests on the VTN. These fields are not used by OpenADR. Clicking the Create Report Request button opens the new Request Report in the edit/view page.

### View/Edit Report Request

The top of the Report Request view/edit page is a list of Report Requests identical to the list of requests displayed on the VEN Report Requests page (see Figure 3-11). The list is repeated here as a convenience.

The next section, Report Request Identification, identifies the Report Request that is being viewed/edit. See Figure 3-13.



**Figure 3-13**  
**Report Request Identification**

In the Report Request Identification section, the user can modify the Name and Description. The Request ID is a unique ID used by the VEN to identify a request.

### ***Send and Cancel a Report Request***

The next section contains a buttons for sending Report Requests to the VEN or cancelling a previous request. See Figure 3-14.

Once the Report Request is configured, the user should send the request to the VEN by clicking the Send Report button.

To cancel a report request that was previously sent to a VEN, click the Cancel Report button. If the VEN should still send the next report, select the checkbox under Report to Follow.

**Figure 3-14**  
**Send and cancel report request**

### **Opt Schedules**

The Opt Schedules list displays all of the opt schedules that the VEN has sent to the VTN. See Figure 3-15.

VEN Settings	Registrations	Resources	Subscriptions	Reports	Opt Schedules
--------------	---------------	-----------	---------------	---------	---------------

Opt Schedules			
Opt ID	Opt Reason	Opt Type	
cb3eae9974-IN	economic	optIn	<a href="#">View/Edit</a> <a href="#">Destroy</a>

**Figure 3-15**  
**The Opt Schedules list**

To view the details of an Opt Schedule, click the View/Edit link in the Opt Schedules screen (see Figure 3-15). Figure 3-16 shows an example Opt Schedule view/edit page.

### Opt Schedule

**Request ID**  
ae13eda2a7

**Opt ID**  
cb3eae9974-IN

**Opt Type**  
optIn

**Opt Reason**  
economic

**Market Context**

**Ven Name**  
Test\_VEN\_Name

**Active**  
true

### Opt Schedule Durations

Start Date	Duration	Notificaiton	Ramp Up	Recovery	Tolerance
2014-09-12 11:00:00 UTC	PT1H				
2014-09-12 08:00:00 UTC	PT1H				
2014-09-12 06:00:00 UTC	PT1H				

Back to VEN

**Figure 3-16**  
**Opt Schedule view**

Opt schedules provide a mechanism for a VEN to indicate to the server its availability to respond to an event. In Figure 3-16, the VEN states that it is available (Opt Type is “optIn”) with a reason of “economic.” The VEN is available during three time periods, each of which is one hour long.

If a VEN cancels an opt schedule, the Active flag will switch to false.

# 4

## CREATING AN ACCOUNT

Only admin users can create an account. To create an account:

1. Select the Accounts link from the Admin Menu. See Figure 4-1.
2. Click the Create Account button.
3. In the New Account screen, enter the User Name, Email (optional), Password, and Password Confirmation. See Figure 4-2. The password must be at least six characters long and the Password and Password Confirmation entries must match.
4. Once the account is created, the user is redirected to the view/edit page of the new account. See Figure 4-3. From the view/edit page the user can be promoted to admin or demoted to non-admin.
5. The user's password can be changed. The other fields are informational only and are not required.

Non-admin users will not see the Administrator Settings, and are actively blocked from changing these settings.

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Logged in as patrick Log out About

**Admin Menu**

- Accounts**
- VENs
- Resource Types
- Market Contexts
- Groups
- Events
- Units
- Schedules
- VTN Parameters
- Test Case Prompts

**User Menu**

- Account Settings
- VENs
- Dashboard
- Download VEN

**Accounts**

**Click Accounts**

User Name	Email	Company	Administrator			
admin			true	Edit/View	Create VEN	Destroy
mitsubishi			true	Edit/View	Create VEN	Destroy
chuck			true	Edit/View	Create VEN	Destroy
enerliance			true	Edit/View	Create VEN	Destroy
bmw			true	Edit/View	Create VEN	Destroy
dmacvitie	dmacvitie@ingraindtech.com		true	Edit/View	Create VEN	Destroy
ben			true	Edit/View	Create VEN	Destroy
connexx			true	Edit/View	Create VEN	Destroy
sumitomo			true	Edit/View	Create VEN	Destroy
patrick			true	Edit/View	Create VEN	Destroy

**Create Account** **Click Create Account**

**Figure 4-1**  
Create account step 1: click *Accounts* and step 2: click *Create Account*

### New Account

User Name

Email

Password

Password Confirmation

Create Account

Back

**Figure 4-2**  
Create account step 2: fill out the form

Administrator Settings

☒ Administrator  

Update Admin Settings

1. Change administrator status

Account Settings

User Name

Email

Account Number

Company

First Name

Last Name

Update Account

Contact Info

Phone

Contact2

Contact3

Contact4

Update Contact Info

Update Password

Password

Password Confirmation

Update Password

2. Change Password

**Figure 4-3**  
Create account step 3: change password or promote/demote to/from admin

# 5

## CREATING A VEN

Create a VEN by following these steps:

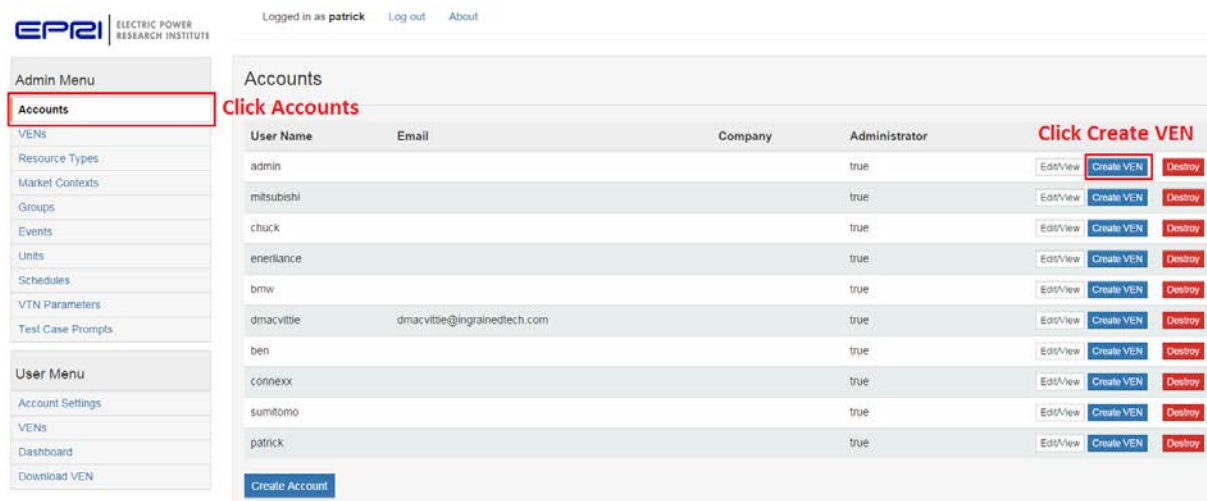
Access the Create New VEN screen in one of two ways:

- a. Admin users can: (1) select Accounts and then (2) click Create VEN to create a VEN for a particular account, as shown in Figure 5-1.

OR

- b. Admin users and regular users can: (1) select the VENs link under the User Menu and then (2) click the Create VEN button at the bottom of the VEN list, as shown in Figure 5-2. This button will create a VEN for the logged-in account.

Following (a) or (b) above opens the new VEN page, as shown in Figure 5-3.



The screenshot shows the EPRI Electric Power Research Institute web application. The top navigation bar indicates the user is logged in as 'patrick' and provides links for 'Log out' and 'About'. On the left, the 'Admin Menu' is visible, with the 'Accounts' option highlighted by a red box. The main content area is titled 'Accounts' and includes a red text prompt 'Click Accounts'. Below this is a table listing accounts with columns for 'User Name', 'Email', 'Company', and 'Administrator'. Each row has three action buttons: 'Edit View', 'Create VEN' (highlighted with a red box), and 'Destroy'. A red text prompt 'Click Create VEN' is positioned above the 'Create VEN' buttons. At the bottom of the table is a 'Create Account' button.

User Name	Email	Company	Administrator	
admin			true	Edit View Create VEN Destroy
mitsubishi			true	Edit View Create VEN Destroy
chuck			true	Edit View Create VEN Destroy
enerlance			true	Edit View Create VEN Destroy
bmw			true	Edit View Create VEN Destroy
dmacvittie	dmacvittie@ingrainedtech.com		true	Edit View Create VEN Destroy
ben			true	Edit View Create VEN Destroy
connexx			true	Edit View Create VEN Destroy
sumitomo			true	Edit View Create VEN Destroy
patrick			true	Edit View Create VEN Destroy

**Figure 5-1**  
Create a VEN step 1 (admin): click *Accounts* and then click *Create VEN*

The screenshot shows the EPRI VENS application interface. On the left is a navigation menu with 'Admin Menu' and 'User Menu'. The 'VENs' item under 'Admin Menu' is highlighted with a red box and labeled 'Click VENs'. In the main content area, the 'VENs' section displays a table of existing VENS. Below the table, a 'Create VEN' button is highlighted with a red box and labeled 'Click Create VEN'.

VEN Name	Registration ID	Account	Last Comm Time	Status		
TH_VEN	d921c1f42a1debc3fd57	patrick	2014-09-02 17:45:40 UTC	offline	<a href="#">View/Edit</a>	<a href="#">Destroy</a>
Test_VEN_Name	3fa2dba3972e08c0798a	patrick	2014-09-12 16:01:48 UTC	offline	<a href="#">View/Edit</a>	<a href="#">Destroy</a>

Below the table, there is a 'Create VEN' button and a red text label 'Click Create VEN'. The footer shows 'Last Refreshed: September 16, 2014 01:14', 'Copyright © 2014 EPRI', and 'v0.9.3'.

**Figure 5-2**  
Create a VEN step 1 (non-admin users): click *VENs* and then click *Create VEN*

The screenshot shows the 'Identification' form for creating a new VEN. It contains three input fields: 'VEN Name', 'Common Name', and 'Account'. The 'Account' field is pre-filled with 'patrick'. A 'Create VEN' button is located at the bottom left of the form.

**Figure 5-3**  
Create VEN step 2: fill in a unique VEN Name

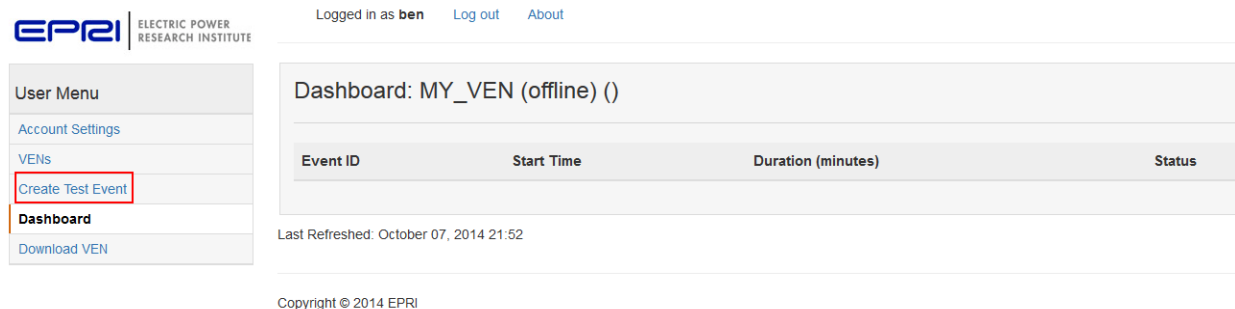
In the new VEN screen, fill in a unique VEN Name and click Create VEN. The VEN view/edit page is then displayed. See Section 3, *Configuring and Managing VENS*.



# 6

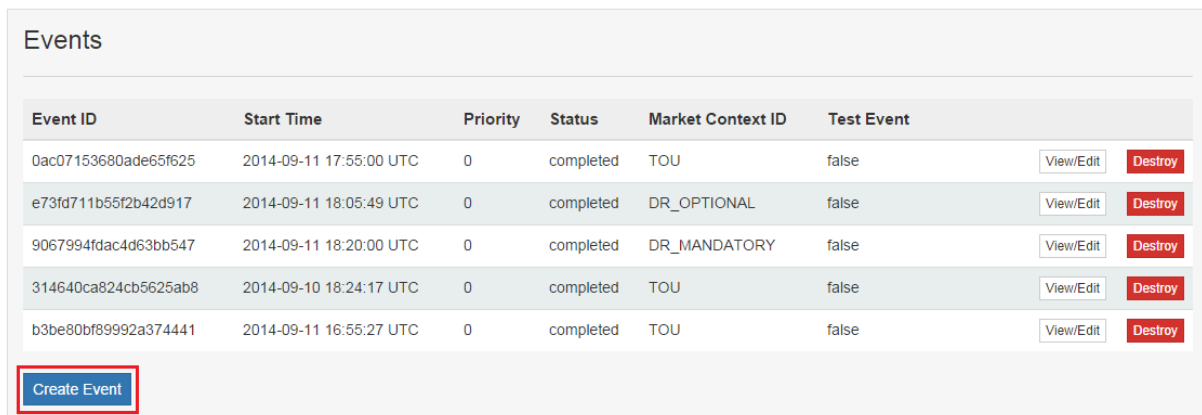
## CREATING AN EVENT

Only admin users can create an event. Non-admin users can create test events by following the Create Test Event link (see Figure 6-1), but the user cannot modify any details of the event (for security reasons) after it has been created.



**Figure 6-1**  
**Creating a test event**

1. Click Create Event, as shown in Figure 6-2.



**Figure 6-2**  
**Create Event button**

2. Configure the time at which the event should start and the duration of the event (Event Details, as shown in Figure 6-3). Next, select the appropriate Signal Name, Signal Type, and Payload Value, and then click Create Event. At this point the event has not yet been made available to VENs. The next step is to publish the event.

The screenshot displays a web-based form for configuring an event. It is divided into two main sections: 'Event Details' and 'Event Signal and Interval'. Below these sections are two buttons: 'Create Event' (green) and 'Back' (white).

**Event Details**

<b>Start Time</b> 2014-09-11 18:32:03 UTC	<b>Duration (minutes)</b> 	<b>Market Context ID</b> TOU ▼
<b>Priority</b> 0	<b>Response Required</b> always ▼	<b>VTN Comment</b> 
<b>Test Event</b> false		

**Event Signal and Interval**

<b>Signal Name</b> simple ▼	<b>Signal Type</b> delta ▼	<b>Payload Value</b> 
--------------------------------	-------------------------------	--------------------------

**Create Event**

**Back**

**Figure 6-3**  
**Event configuration**

3. After the event has been created, the user can configure the event settings. The Event Settings fields are included in five different functional screens:
  - a. Fields of the Event Descriptor screen include Event ID, Priority, Market Context ID, Status, VTN Comment, Test Event, Created At (date/time of event creation), and event Modification Number. See Figure 6-4.
  - b. Fields of the Active Period screen include details of when the event should begin, event Duration, Tolerance, Notification, Ramp up, and Recovery. See Figure 6-4.
  - c. The Response Required screen has one field to indicate whether the VEN is required to respond to the event.
  - d. Fields of the Event Signals screen include Signal Name, Signal Type, and Current Value for the event. Multiple signal names, types, and levels can be assigned to an event.
  - e. In the Targets screen, events can be disseminated to a specific VEN or to a set of Groups, Resources, VENs, or Parties. See Figure 6-5.

### Active Period

Event ID

b3be80bf89992a374441

Priority

0

Market Context ID

TOU

Status

completed

VTN Comment

TOU-TEST

Test Event

false

Created At

2014-09-11 17:00:30.289

Modification Number

1

Save

### Event Descriptor

Start Time

2014-09-11 16:55:27 UTC

Duration (minutes)

5

Tolerance (minutes)

0

Notification (minutes)

0

Ramp up (minutes)

0

Recovery (minutes)

0

Save

**Figure 6-4**  
**Active Period and Event Descriptor**

Copyright © 2014 EPRI v0.9.3

**Figure 6-5**  
**Targets**

- After the event is configured, the Event can be Published or Cancelled. See Figure 6-6.  
Note: The screen shots below precede the Event Settings screen.

Copyright © 2014 EPRI v0.9.3

**Figure 6-6**  
**Publish Event and Cancel Event**

### ***Signals and Intervals***

Intervals in a signal become active in an order based on the interval's UID. The UID must start with 0 and increment by 1 (though the system does not enforce this rule).

A single event can target Profile 2.0a and Profile 2.0b VENs. When an event is generated for a Profile 2.0a VEN, the following rules apply:

- Profile 2.0a supports only one signal, so only the first signal will be included in the event message sent to the VEN
- Profile 2.0a supports the “simple” Signal Name only. Signals are hard-coded to use this name.
- Profile 2.0b introduces a few new signal types. If a signal type is selected that is not supported by Profile 2.0a, the Signal Type field defaults to LEVEL.
- Profile 2.0a limits the payload values to numbers between 0 and 3 (inclusive). To support these payload values, intervals contain a “Profile 2.0a Payload” field that is sent to Profile 2.0a VENs.

The UID field in an interval determines the order in which intervals become active. The active interval determines the Current Value field of an Event Signal.

See the OpenADR profile specification for more information on compatibility between profiles 2.0a and 2.0b. The documents can be downloaded from the alliance website at <http://www.openadr.org>.



# 7

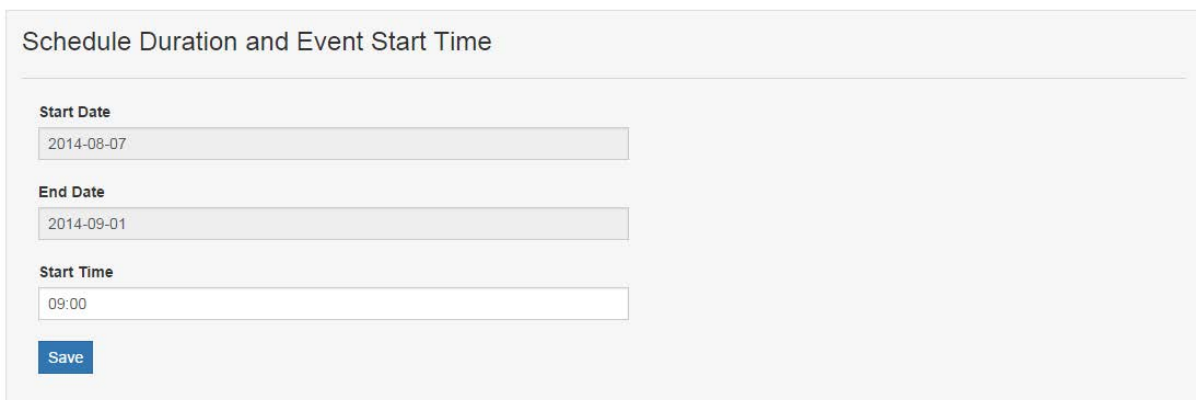
## CREATING A SCHEDULE

Creating a schedule is similar to creating an event. Schedules add two new sections to the event view/edit page: *Schedule Duration and Event Start Time* and *Schedule*. See Figure 7-1 and Figure 7-2.

The list of schedules can be accessed by clicking the Schedules link (see *Schedules* under Section 2). Besides these two additional sections, editing a schedule is the same as editing an event.

A service that executes on the server watches the schedules and determines when an event should be created. An event is created when the current time matches the start time of the event minus the max of (0, Notification, Ramp up) (in minutes). For example, if a schedule is created with a Notification of 5, a Ramp Up of 6, and a start time of 10:00, the event will be created at 9:54 (10:00 – 6 minutes). Since Notification and Ramp up can be negative, a 0 is added to the max function to ensure the events are created at the event start time at the latest.

The server time zone is used for schedules.



Schedule Duration and Event Start Time

Start Date  
2014-08-07

End Date  
2014-09-01

Start Time  
09:00

Save

**Figure 7-1**  
**Schedule Duration and Event Start Time**

### Weekdays

Monday

☒

Tuesday

☒

Wednesday

☒

Thursday

☒

Friday

☒

Save

### Weekends

Saturday

☒

Sunday

☒

Save

**Figure 7-2**  
**Event schedule**



# 8

## USER MENU

Non-admin users have limited access to the system. The User Menu consists of five links: Account Settings, VENs, Create Test Event, Dashboard, and Download VEN. See Figure 8-1.



User Menu
Account Settings
VENs
Dashboard
Download VEN

**Figure 8-1**  
**The non-admin User Menu**

### ***Account Settings***

Users can modify their account details and change their password from the Account Settings page. Users will see the same information shown in Figure 4-3, minus the admin settings at the top of the page.

### ***VENs***

The user VENs link lists all of the VENs associated with the logged-in account. The user can manage existing VENs, create a new VEN, or delete an existing VEN. See Section 3 for information on managing VENs.

### ***Create Test Event***


Users can create test events through the Create Test Event link. The Create Test Event page has the same options as the Create Event page (see Figure 6-1).

Once a test event is created, non-admin users cannot modify any aspects of the event. The event will be marked as a test event, and all VENs registered with the account will be listed as targets.

### ***Dashboard***

The dashboard provides an overview of the status of the logged-in user's VENs. For each VEN, the dashboard shows: (1) the VEN Name and Status as well as (2) the Last Communication Time. Below the VEN status is a list of events that target that VEN.

The dashboard page refreshes automatically every five seconds. The bottom of the screen shows the last time the page was refreshed.



Electric Power Research Institute

Admin Menu

- Accounts
- VENs
- Resource Types
- Market Contexts
- Groups
- Events
- Units
- Schedules
- VTN Parameters
- Test Case Prompts

User Menu

- Account Settings
- VENs
- Dashboard**
- Download VEN

Logged in as patrick

Log out

About

Name and Status

Last Comm Time

Dashboard: TH\_VEN (offline)

(2014-09-02 17:45:40 UTC)

Event ID	Start Time	Duration (minutes)	Status	Test Event	Opt State
4f0897ef0fd46132ff5f	2014-09-12 17:37:57 UTC	5	completed		

Dashboard: Test\_VEN\_Name (offline)

(2014-09-12 18:01:48 UTC)

Event ID	Start Time	Duration (minutes)	Status	Test Event	Opt State
----------	------------	--------------------	--------	------------	-----------

Last Refreshed: September 16, 2014 01:18

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v0.9.3

**Figure 8-2**  
The dashboard

### Download VEN

The final link under the user menu is a link to download a VEN. Please see *Download the VEN* under Section 1 for more information.

# 9

## **RUNNING TEST CASES AGAINST THE TEST SET**

The Test Case Prompt link aids in testing with the QualityLogic test harness. The test harness has more than 60 EiEvent test cases, each of which has requirements for creating and modifying events. The prompts on this page will automatically create and modify events as needed by the test set.

To configure the VTN for testing with the test harness, follow the instructions under *VTN Parameters* and *Test Case Prompts* in Section 2.



# 10

## INSTALLATION

### Installation Notes

EPRI's OpenADR VTN was developed and tested on an Ubuntu 12.04 desktop and server. Limited testing has been done on Mac OS X. The software has not been tested on Windows Server, although all of the software used to run the OpenADR VTN runs on Windows. The following instructions are for Ubuntu Server 12.04.

Configuring TorqueBox, MySQL, and the Apache HTTP Server is a complex process. The following instructions are meant as a guideline for running the OpenADR VTN, not a template for securing a production environment.

It is advisable not to expose the OpenADR VTN outside your firewall if SSL is not turned on, because the OpenADR services (EiEvent, EiReport, EiOpt, and EiRegisterParty) do not perform authentication. The services assume that SSL authentication with client-side certificates has been performed before messages reach them. The OpenADR VTN is designed to be deployed behind an Apache reverse proxy HTTP server, which handles SSL. A sample Apache config file is included in the server documentation directory.

The following commands should work on most flavors of Linux, though they were only tested on Ubuntu.

### Setup and Configure the Server

1. Install Java 7:

```
sudo apt-get install openjdk-7-jdk.
```

This will install the OpenJDK version of Java, not the Sun (Oracle) version. Some features may not be available in the OpenJDK version. If you experience issues, please follow your operating system instructions for installing Java from Oracle.

2. Install a database:

- a. The default database for the application is PostgreSQL. Ubuntu installation instructions can be found here: <https://help.ubuntu.com/community/PostgreSQL>. A database that supports Any Active Record can be used, but the application was written and tested with PostgreSQL.
- b. Create a database for the application.
- c. Create a user for the application and give the user full rights to the database created in the previous step.

3. Set up a torquebox user and install TorqueBox:

```
sudo adduser torquebox --disabled-login
```

```
sudo mkdir /opt/torquebox
```

```
sudo chown torquebox:torquebox /opt/torquebox
```

```
wget http://torquebox.org/release/org/torquebox/torquebox-dist/3.0.2/torquebox-dist-3.0.2-bin.zip
```

```
sudo su torquebox
```

```
unzip torquebox-dist-3.0.2-bin.zip -d /opt/torquebox/
```

```
cd /opt/torquebox
```

```
ln -s torquebox-3.0.2 current
```

4. Add the following lines to the torquebox user's ~/.bashrc file:

```
export TORQUEBOX_HOME=/opt/torquebox/current
```

```
export JBOSS_HOME=$TORQUEBOX_HOME/jboss
```

```
export JRUBY_HOME=$TORQUEBOX_HOME/jruby
```

```
PATH=$JBOSS_HOME/bin:$JRUBY_HOME/bin:$PATH
```

```
export RAILS_ENV=production
```

5. To make the changes in step 4 available to the current terminal, run the following command:

```
source ~/.bashrc
```

Alternatively, restart the console. These paths are needed for the next section.

## Set up the Application

The following commands should all be run as the torquebox user. To switch to the torquebox user, run

```
sudo su torquebox
```

1. Copy oadr.knob to /home/torquebox/oadr and unzip the file:

```
unzip oadr.knob
```

2. Switch to /home/torquebox/oadr. If you receive errors running the following commands, double-check that the export paths above (steps 4 and 5) are set correctly and that TorqueBox is installed correctly.

3. Install rails:

```
gem install rails
```

4. Install the application gems:

```
bundle install
```

5. Prepare the application assets (this command will take a few minutes: be patient):

```
rake assets:precompile
```

6. Configure the application database:

- a. Copy config/database.yml.example to config/database.yml.

- b. Edit config/database.yml. Under production: set the appropriate database, username, password, and host.
7. Configure TorqueBox services:
  - c. Copy config/torquebox.yml.example to config/torquebox.yml

The default settings will work for most applications. If you require XMPP or need to enable or disable host name validation on push VENs, this file will need to be modified. Modifying the TorqueBox config file requires the service to be restarted before changes will take effect.
8. Set up a secret token:
  - d. Generate a secret:
 

```
rake secret
```
  - e. Copy the output from the above command to: config/initializers/secret\_token.rb.
  - f. The last line in secret\_token.rb should look like this:
 

```
Oadr::Application.config.secret_token = "place token here"
```
9. Set up the database:
 

```
rake db:schema:load
```
10. Seed the database:
 

```
rake db:seed
```
11. Load test case prompts (if desired):
 

```
rake db:loadtests
```
12. Deploy the application to production:
 

```
torquebox deploy --env=production. # (note: there are two dashes in front of env)
```
13. Test the installation by running TorqueBox:
 

```
torquebox run -b 0.0.0.0
```

This will start TorqueBox listening on all local interfaces on port 8080, allowing you to test that the application is working. Load the login screen in a browser by visiting <http://localhost:8080>. After verifying that the login screen loads, hit <ctrl+c> to stop TorqueBox.
14. Next, install the TorqueBox upstart script. The oadr/documentation directory contains a script called torquebox.conf. Copy this file (as root) to /etc/init/.
15. Start TorqueBox through upstart:
 

```
sudo start torquebox.
```

Similarly, to stop TorqueBox, run

```
sudo stop torquebox
```

Note that the upstart script will start TorqueBox when the server restarts.

16. Verify that TorqueBox is running by tailing the log file:

```
tail -f /var/log/torquebox/torquebox.log.
```

17. By default, TorqueBox will listen on 127.0.0.1. To make the application available outside the localhost, change the inet-address parameter in /opt/torquebox/current/jboss/standalone/configuration/standalone.xml.

18. After starting TorqueBox, check that the application started without issue by looking at the TorqueBox log file in /var/log/torquebox/torquebox.log. Look for errors like this:

```
(NameError) missing class or uppercase package name
('epri.oadr2b.lib.OadrPayload')
```

This error indicates that TorqueBox is finding the wrong JVM; the application will not run under Java 6. You may need to uninstall Java 6. On Ubuntu, run the following command to make Java 7 the default:

```
sudo update-alternatives --config java
```

After running the above command, you will be presented with a list of options. Type the number that corresponds to Java 7 and press Enter.

## Log Files

Should you run into issues, the following log files should be examined:

- Application: /home/torquebox/oadr/log/[production | error | info].log.
- Apache HTTP Server: /var/log/apache2/\*
- TorqueBox: /var/log/torquebox/torquebox.log

The log files in /home/torquebox/oadr/log can grow very large. It's advisable to manage the files with logrotate.

## Set up and Configure Apache with SSL

OpenADR2.0 certification requires a server to be configured with TLS1.2. EPRI's VTN uses an Apache HTTP Server reverse proxy to handle SSL. A sample Apache config file can be found in the documentation directory. The file is called oadr-ssl.conf.

This file configures Apache to use RSA and ECC certificates, restricts the cipher suites to those listed in the OpenADR2.0 specification, and requires client-side certificates for all requests using the OpenADR2.0 service end points. Certificates have only been tested in PEM format, but other formats may work as well.

Test and production certificates can be obtained from NetworkFx

(<http://www.networkfx.net/netfx/>). Certificate packages from NetworkFX include a private key and certificate and a few root certificates (see Figure 10-1). The root certificates are signified by the letters CA (certificate authority) in the name.

Applications that use SSL (such as Apache) require three files: a CA bundle, a private key, and a certificate. Before a NetworkFX private key and certificate can be used with the provided Apache config file, they must be converted from DER encoding to PEM format. The CA bundle can be created by appending all CA files found in one VEN and one VTN certificate package.



First convert the files from DER encoding to PEM format and then append them to the same file. Both RSA and ECC CA certificates can be included in a single bundle.

See the resources below for more information on how configure Apache and convert files from DER encoding to PEM format.

Name	Size	Packed Size
TEST_OpenADR_RSA_RCA0001_Cert.crt	1 397	1 318
TEST_OpenADR_RSA_SPCA0002_Cert.crt	1 663	1 241
TEST_RSA_VTN_13082984729_cert.crt	944	868
TEST_RSA_VTN_13082984729_privkey.der	1 218	1 223

**Figure 10-1**  
VTN test certificates from NetworkFx

## Installation Resources

1. Running TorqueBox on Debian: <http://www.headlondon.com/our-thoughts/technology/posts/installing-torquebox-application-server-on-debian>
2. Apache in front of Rails: <http://www.scatmania.org/projects/ssl-client-certificate-authentication-in-ruby-on-rails/>
3. Additional Apache with SSL sites:  
<http://dev.mensfeld.pl/2013/06/jenkins-behind-apache-with-https-proxy-pass-with-ssl/>  
<http://whatimean.wordpress.com/2008/02/20/ssl-for-apache-and-rails>
4. Verifying certificates with OpenSSL:  
<https://kb.wisc.edu/middleware/page.php?id=4064>  
<https://kb.wisc.edu/middleware/page.php?id=4543>
5. OpenSSL (see the bottom of the page for converting cipher strings from the RFCs to the values expected by OpenSSL)  
<https://www.openssl.org/docs/apps/ciphers.html>

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