Software Requirements Specification (SRS) Document

Virtual Power Plant

Team 46

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Client: Manish Tiwari

Brief problem statement

To implement demand response for Electric Vehicle charging.An aggregator module will be built where charge point operator resources(called CSMS) will be aggregated. This module is called VEN(Virtual End Node).VEN registered by the power provider must be able to send prices and power saving commands to the charging station. This is the primary task as of now.We will also provide APIs for their CSMS.

System requirements

1. Electric grid integration: OpenADR 3.0
2. REST API development: Express.js

Users profile

1. **System Administrators**
   - Technical Expertise: Advanced
   - Computing Skills: Profound understanding of grid systems, networking, and security protocols
   - Usage Pattern: Daily
   - Background: IT professionals trained in power systems and OpenADR protocols
   - Typical Interaction: Handle system configuration through a number of advanced interfaces
   - Technology Comfort: Capable of handling technical issues and system integrations

2. **Utility Grid Operators**
   - Technical Expertise: Intermediate
   - Computing Skills: Familiarity with control systems and grid management software
   - Usage Pattern: 24/7 shift-based monitoring and control
   - Background: Power systems engineers and grid operation specialists
   - Typical Interaction: Regular monitoring and response through dashboard interfaces
   - Technology Comfort: Experienced with SCADA and similar control systems

3. **DER Asset Operators**
   a. EV Charging Station Managers
   - Technical Expertise: Intermediate
   - Computing Skills: Good understanding of charging management systems
   - Usage Pattern: Regular daily operations and monitoring

- Background: Technical operators with specific EV infrastructure training
- Typical Interaction: Station management through web-based interfaces
- Technology Comfort: Moderate, familiar with commercial software systems

  b. Other DER Operators (Solar, Building, Industrial, Battery)
  - Technical Expertise: Intermediate
  - Computing Skills: Comfortable with specialized management software
  - Usage Pattern: Regular monitoring and adjustment of resources
  - Background: Facility managers and technical operators
  - Typical Interaction: Resource-specific control interfaces
  - Technology Comfort: Moderate to high, varying by specific resource type
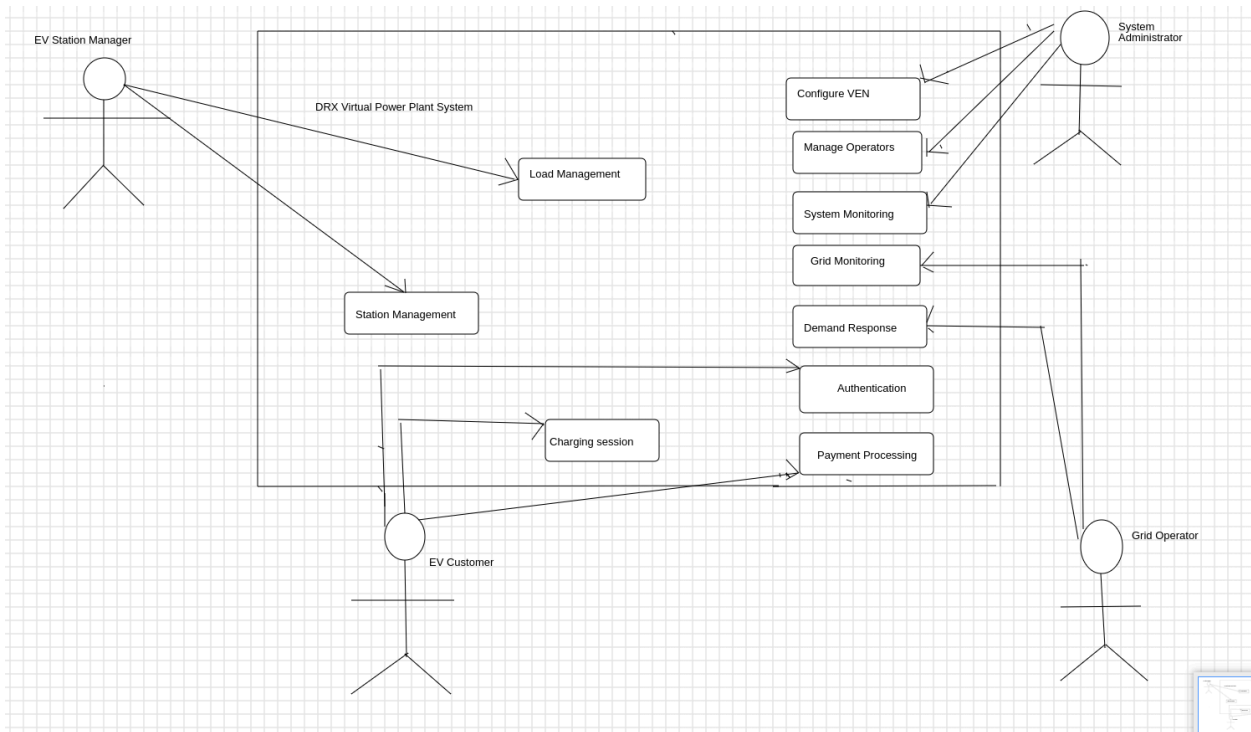
4. **EV Charging Customers**
  - Technical Expertise: Basic
  - Computing Skills: Familiar with mobile apps and basic payment systems
  - Usage Pattern: Occasional, as needed for charging sessions
  - Background: General public with varying technical literacy
  - Typical Interaction: Mobile apps and simple station interfaces
  - Technology Comfort: Variable, system designed for intuitive use

Feature requirements (described using use cases)

No.	User Case Name	Description	Release
	EV charging customers		
1.	Authentication	Customers register accounts and set up authentication methods for accessing charging stations. This includes linking payment methods and managing RFID cards or mobile app access.	R1
2.	Charging Session	Customers initiate and manage charging sessions using their preferred authentication method. They can monitor charging progress, stop sessions, and view their charging history through the mobile app.	R1
3.	Payment Processing	Customers manage payments for charging services, including setting up payment methods and viewing transaction history. They can configure auto-payment options and access billing information through their account.	R1
	System Administrator		
4.	Provide APIs for New VEN Resource Integration	System administrator sets up new resource types in the VPP system by configuring VEN parameters and communication protocols. This process includes defining resource limits, testing connectivity, and ensuring proper data flow between the resource and the VPP platform.	R2
5.	Manage operator access	Administrator creates and manages accounts for different operator types, assigning appropriate permissions based on their roles. This includes handling user authentication, authorization levels, and monitoring operator activities to ensure system security.	R2
6.	System monitoring and maintenance	Involves overseeing the entire system's performance, identifying potential issues, and implementing necessary updates. The administrator monitors system health metrics and coordinates maintenance activities to ensure optimal system operation.	R2
	Utility grid operators		
7.	Grid Monitoring	Operators continuously monitor grid frequency, stability, and resource availability through real-time dashboards. They analyze grid performance metrics and identify potential issues that might affect grid stability	R2
8.	Demand Response Management	Operators initiate and manage demand response events based on grid conditions and requirements. This includes setting load reduction targets, monitoring event progress, and ensuring participant compliance with event parameters.	R2
9.	Resource Coordination	Involves balancing loads across different DER resources to maintain grid stability and optimize resource utilization. Operators coordinate resource scheduling and manage emergency situations requiring immediate response.	R2
	DER asset operator		
10.	Resource Management	Operators monitor and control their specific DER resources, configuring operational parameters and tracking performance. This includes setting response preferences and ensuring resource availability for grid services.	R2
11.	Program Participation	Asset operators configure their participation in demand response and other grid service programs. They set participation limits and automation rules based on their resource capabilities and operational constraints.	R2

Use case diagram

EV Station Manager

DRX Virtual Power Plant System

System Administrator

- Configure VEN
- Manage Operators
- System Monitoring
- Grid Monitoring
- Demand Response
- Authentication
- Load Management
- Station Management
- Charging session
- Payment Processing

EV Customer

Grid Operator

Use case description:

Use Case Number:	UC-01
Use Case Name:	User Authentication
Overview:	Users authenticate themselves to access the system based on their role and permissions. This includes all user types from System Administrators to EV Customers.
Actors:	All Users (System Administrator, Grid Operator, EV Station Manager, DER Operator, EV Customer)
Pre condition:	- User has registered account - Authentication system operational - Authentication method available (credentials/RFID/mobile app)
Flow:	1. User initiates authentication process 2. System prompts for authentication method 3. User provides authentication credentials 4. System validates credentials 5. System verifies user role and permissions 6. System grants appropriate access level 7. System logs authentication event 8. User receives access confirmation

	Alternate Flows:
	  4 Invalid credentials
	    - System displays error message
	    - Prompt to retry
	    - Lock account after multiple failures

Post Condition:	- User authenticated - Access level established - Authentication logged

Use Case Number:	UC-02
Use Case Name:	Charging Session
Overview:	Customer initiates and manages charging session
Actors:	EV Customer, EV Station
Pre condition:	1. Authentication successful 2. Station available
Flow:	1. Select charging station 2. Choose charging options 3. Start session 4. Monitor progress 5. Receive updates

	6. End session
	Alternate Flows: - Station error: Select alternative - Session interruption: Restart process
Post Condition:	Charging complete, session recorded

Use Case Number:	UC-03
Use Case Name:	Payment Processing
Overview:	EV Customer processes payment for charging services using various payment methods.
Actors:	EV Customer, Payment System
Pre condition:	- User authenticated - Payment system operational - Valid payment method registered - Charging session completed/ready to start
Flow:	1. System displays payment requirement 2. Customer selects payment method 3. System validates payment method 4. System calculates charge amount 5. Customer confirms payment 6. System processes payment transaction 7. Payment gateway confirms transaction 8. System records payment 9. System issues receipt 10. System updates charging credits

	Alternate Flows:
	 3. Payment method invalid
	  * Prompt for alternative method
	   * Option to add new payment method
	   * Cancel transaction
	
	 6. Payment declined
	
	 * Display decline message
	  * Offer retry option
	  * Suggest alternative payment method
	
	 6. Connection error:
	  * Save transaction details
	  * Retry connection
	  * Offer offline payment option

Post Condition:	- Payment processed - Transaction recorded - Receipt generated - Account balance updated .

Use Case Number:	UC-04
Use Case Name:	Provide APIs for New VEN Resource Integration
Overview:	System Administrator configures new VEN resources in the VPP system, establishing integration and communication protocols.We will only be providing the APIs
Actors:	System Administrator
Pre condition:	- System Administrator is authenticated - Resource information available - OpenADR 3.0 protocol operational .
Flow:	1. Select "Add New Resource" 2. Enter resource parameters 3. Configure OpenADR settings 4. Validate configuration 5. Test connection 6. Activate resource .
	Alternate Flows: 4. Validation failure: return to step-2 5. Connection failure: return to step-3
Post Condition:	- VEN resource operational - Monitoring active .

Use Case Number:	UC-05
Use Case Name:	Manage operator access
Overview:	System Administrator manages access rights and permissions for all operator types.
Actors:	System Administrator
Pre condition:	- Administrator authenticated - Operator information available
Flow:	1. Access operator management interface 2. Select operator type 3. Configure access rights 4. Set operational limits 5. Assign resources

	6. Create credentials 7. Validate settings
	Alternative flows: 7. Invalid configuration: return to step-3 6. Duplicate credentials: Request new credentials
Post Condition:	Operator account active, Access rights configured

Use Case Number:	UC-06
Use Case Name:	System monitoring and maintenance
Overview:	System Administrator monitors overall system health and performance.
Actors:	System Administrator
Pre condition:	- System operational - Monitoring tools active
Flow:	1. Access monitoring dashboard 2. Review system metrics 3. Check resource status 4. Analyze performance data 5. Generate reports 6. Address alerts
	Alternate Flows: 3. System alert: Initiate diagnostic 5. Performance issue: Begin troubleshooting
Post Condition:	- System status updated - Reports generated

Use Case Number:	UC-07
Use Case Name:	Grid Monitoring
Overview:	Grid Operator monitors grid stability and resource availability.
Actors:	Grid Operator
Pre condition:	- Grid monitoring systems active - Operator authenticated
Flow:	1. View grid status dashboard 2. Monitor frequency metrics 3. Check resource availability 4. Review demand patterns 5. Analyze grid stability

	6. Document observations .
	Alternate Flows: 4. Resource unavailability: Adjust planning 6. Grid instability: Initiate DR event
Post Condition:	- Grid status documented - Resources monitored .

Use Case Number:	UC-08
Use Case Name:	Demand Response Management
Overview:	Grid Operator initiates and manages demand response events.
Actors:	Grid Operator, Resource Operators
Pre condition:	- Grid requires demand response - Resources available

Flow:	Main (success) Flow:
	   1. Identify DR need
	   2. Select participating resources
	   3. Set event parameters
	   4. Initiate event
	   5. Monitor response
	   6. Adjust as needed
	   7. End event

	Alternate flows: 6. Insufficient response: Escalate event - Emergency cancellation: Terminate early
Post Condition:	- DR event completed - Results recorded

Use Case Number:	UC-09
Use Case Name:	Resource Coordination
Overview:	Grid Operator coordinates and balances different DER resources to maintain grid stability and optimize resource utilization across the network.
Actors:	Grid Operator, DER Asset Operators, EV Station Managers
Pre condition:	- Grid Operator authenticated - Resources operational and communicating - Real-time resource status available - Grid metrics being monitored
Flow:	Main (success) Flow: 1. Monitor grid stability metrics 2. View available resource capacity across all DERs

	3. Analyze current load distribution 4. Identify optimization opportunities 5. Calculate optimal resource allocation 6. Issue coordination commands to resources 7. Monitor resource responses 8. Adjust allocation in real-time 9. Log coordination actions 10. Generate performance metrics

	Alternate Flows:
	3. Resource unavailability:
	  - Recalculate allocation without unavailable resource
	  - Notify affected operators
	  - Update coordination plan

Post Condition:	- Resources optimally coordinated - Grid stability maintained - Coordination actions documented - Performance data recorded

Use Case Number:	UC-10
Use Case Name:	Resource Management
Overview:	DER Operator manages specific resource operations and availability
Actors:	DER Asset Operator
Pre condition:	- Resource registered - Operator authenticated
Flow:	Main (success) Flow: 1. Access resource controls 2. Set operational parameters 3. Monitor performance 4. Adjust settings 5. Maintain availability data 6. Report status
	Alternate Flows: 2. Resource failure: Initiate maintenance 4. Performance issues: Optimize settings
Post Condition:	- Resource managed - Status updated

Use Case Number:	UC-11
Use Case Name:	Program Participation
Overview:	DER Operator manages participation in grid services programs.

Actors:	DER Asset Operator, Grid Operator
Pre condition:	- Program eligibility confirmed - Resource capable .
Flow:	1. Review program requirements 2. Configure participation parameters 3. Set response preferences 4. Monitor participation 5. Track performance 6. Report results .

	Alternate Flows:
	   1. Program changes: Update settings
	   2. Non-compliance: Adjust parameters

Post Condition:	- Participation managed - Performance tracked .