EV CHARING SLOT RESERVATION & LOAD MANAGEMENT

Software Requirement Specification

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SOFTWARE REQUIREMENTS SPECIFICATION (SRS)

PROJECT: EV CHARGING SLOT RESERVATION & LOAD MANAGEMENT SYSTEM

1. Introduction:

1.1 Purpose

This Software Requirements Specification document outlines the complete software requirements of the EV Charging Slot Reservation & Load Management System.
It describes functional and non-functional requirements, system architecture, interfaces, and constraints.

1.2 Scope

The system enables EV users to reserve charging slots, monitors charger health in real-time, balances load intelligently, manages queues, applies dynamic pricing, and provides dashboards for operators.

1.3 Definitions

- **EV** – Electric Vehicle
- **SOC** – State of Charge
- **Load Management System** – Module that balances station energy usage
- **Slot Reservation** – Booking specific time window
- **Fast Charger** – High capacity charger (50–120 kW)
- **Slow Charger** – Low capacity charger (3–7 kW)

1.4 Document Audience

- Developers
- QA/Testers
- Architects
- BA & PO teams
- Operations

2. Overall Description:

2.1 Product Perspective

The system will function as a centralized cloud platform connected to EV stations.
Components:

1. **Mobile/Web App (User Interface)**
2. **Slot Reservation Engine**

3. **Charger Telemetry System (IoT)**
4. **Load Management Engine**
5. **Dynamic Pricing Engine**
6. **Notification Service**
7. **Operator Dashboard**

2.2 User Classes

User Type	Description
EV User	Books slots, monitors charging
Station Operator	Manages station capacity & operations
Admin	Manages stations, chargers & configurations
Load Engine	Automated backend service
Pricing Engine	Pricing rule processor

3. System Features:

Below are the detailed software requirements:

3.1 Slot Reservation System

3.1.1 Feature Description

Provides users the ability to reserve a charging slot at a chosen time and location.

Functional Requirements

1. System shall allow users to search available stations.
2. System shall display available and reserved time slots.
3. System shall allow booking of 30–90 min time slots.
4. System shall validate charger compatibility with vehicle.
5. System shall auto-expire booking after 10 minutes if user does not arrive.
6. System shall send booking confirmation via SMS/email/app notification.

Inputs

- Station ID
- Charger ID
- Date
- Time

- Vehicle details

Outputs

- Booking confirmation ID
- Updated slot availability

3.2 Real-Time Charger Monitoring

3.2.1 Feature Description

Collects charger telemetry and updates its real-time status.

Functional Requirements

1. System shall fetch charger telemetry every 10 seconds.
2. System shall check charger temperature, voltage, and current.
3. System shall update state: Available / In Use / Reserved / Faulty.
4. System shall alert operator in case of charger failure.

Inputs

- Charger load
- Temperature
- Electrical signals

Outputs

- Updated status
- Alerts

3.3 Load Management Engine

3.3.1 Feature Description

Balances electrical load based on real-time power consumption.

Functional Requirements

1. System shall calculate total load every 5 seconds.
2. System shall compare load with threshold.
3. System shall auto-delay new sessions if load exceeds safe limit.
4. System shall dynamically assign power across chargers.
5. Emergency vehicles override normal load rules.

Inputs

- Charger load
- Grid load
- Active sessions

Outputs

- Adjusted load distribution
- Load alerts

3.4 Queue Management System

3.4.1 Feature Description

Automatically manages waiting users when slots are unavailable.

Functional Requirements

1. System shall add user to queue if no slots available.
2. Queue shall be FIFO.
3. Emergency vehicles bypass queue.
4. System shall notify user when slot is available.
5. User must confirm within 5 minutes.

3.5 Dynamic Pricing Engine

3.5.1 Feature Description

Calculates optimal pricing depending on usage and demand.

Functional Requirements

1. System shall compute price based on:
    - Charger type
    - Peak/off-peak time
    - Demand
    - Energy usage
2. System shall refresh prices every 15 minutes.
3. System shall display updated price to user.

3.6 Charging Session Management

Functional Requirements

1. System shall start session when user plugs in.
2. System shall monitor electricity consumed in real-time.
3. System shall auto-stop session if time ends or battery full.
4. System shall store session details.

3.7 Notification Engine

Functional Requirements

1. Sends:
   - Booking confirmation
   - 30-min reminder
   - Queue updates
   - Charging start/stop
   - Emergency alerts
2. Supports SMS, Email, Push.

3.8 Operator Dashboard

Functional Requirements

1. Must display charger count and statuses.
2. Must display load graph.
3. Must display bookings, queue, forecasting.
4. Must allow operator to mark charger as Faulty/Active.

4. External Interface Requirements:

4.1 User Interface (UI) Requirements

Mobile/Web App Screens

1. Login
2. Home screen with nearest stations
3. Slot booking screen
4. Booking history
5. Charging session screen
6. Queue screen

Operator Dashboard Screens

1. Load Dashboard
2. Real-time charger map
3. Alerts screen
4. Booking management

4.2 Hardware Interfaces

- IoT-enabled Chargers
- Station Load Controller
- Power Grid Status Feed

4.3 Software Interfaces

- Notification API
- Pricing Engine API
- Charger Telemetry API
- Authentication API

5. Non-Functional Requirements:

5.1 Performance

- Booking response time < 2 seconds
- Telemetry refresh < 10 seconds

5.2 Security

- JWT-based authentication
- Data encryption at rest and transit
- Role-based access control

5.3 Scalability

- Supports 10,000+ simultaneous users
- Scales to 1000+ stations

5.4 Reliability

- 99.9% uptime
- Auto-retry for failed API calls

5.5 Usability

- App must follow standard UI guidelines
- All screens accessible within 2 taps

5.6 Maintainability

- Modular microservice-based architecture
- Clear logging and monitoring

6. Data Model Requirements:

Entities & Attributes

- **User:** user_id, name, email, phone
- **Vehicle:** vehicle_id, model, battery_size
- **Station:** station_id, location
- **Charger:** charger_id, charger_type, status
- **Booking:** booking_id, slot_time, duration
- **Queue:** queue_id, position
- **Session:** session_id, start_time, end_time
- **Load:** load_id, load_value

7. Constraints:

- Charger API availability
- Internet connectivity for real-time updates
- Local regulations for peak hour load

8. Assumptions:

- Charger sends telemetry every 10 seconds
- Users have working internet
- Payment integration is Phase 2

9. Acceptance Criteria:

- Covered in separate AC document.

10. Appendices:

- Process flows
- Mock screens
- Architecture diagram