Software Requirements Specification Template

Software Engineering

The following annotated template shall be used to complete the Software Requirements Specification (SRS) assignment.

Template Usage:
Text contained within angle brackets (‘<’, ‘>’) shall be replaced by your project-specific information and/or details. For example, <Project Name> will be replaced with either ‘Smart Home’ or ‘Sensor Network’.

Italicized text is included to briefly annotate the purpose of each section within this template. This text should not appear in the final version of your submitted SRS.

This cover page is not a part of the final template and should be removed before your SRS is submitted.

Theater Ticketing System

Software Requirements Specification

<Version>

7-8-2025

Group 10
Anh Vo, Luis Do, Michael Pham

Prepared for
CS 250- Introduction to Software Systems
Instructor: Gus Hanna, Ph.D.
Summer 2025

Revision History

Date	Description	Author	Comments
<date>	<Version 1>	<Your Name>	<First Revision>

Document Approval

The following Software Requirements Specification has been accepted and approved by the following:

Signature	Printed Name	Title	Date
	<Your Name>	Software Eng.	
	Dr. Gus Hanna	Instructor, CS 250	

Table of Contents

1. Introduction

1.1 Purpose

The purpose of this document is to outline the requirements and specifications for software engineers to develop a functioning ticketing system for theaters to use.

1.2 Scope

1. Movie Theater Ticketing System
2. The ticketing system will handle the seating and ticket sales for 20 theaters in the San Diego area. The system will be browser-based and accessible both inside and outside the theater. It will be an interface that allows consumers to purchase ticket(s) and pick seating, along with supporting various factors such as discounts and implementing various constraints to the purchasing of tickets.
3. The system will be implemented in devices inside theater lobby areas, allowing customers to easily purchase tickets and choose seating for upcoming showtimes. The goal of the system is to provide a smooth and streamlined experience to choosing a movie, picking seating, and paying for the ticket.

1.3 Definitions, Acronyms, and Abbreviations

- SRS – Software Requirement Specification
- UI – User Interface
- DB – Database

1.4 References

This subsection should:
(1) Provide a complete list of all documents referenced elsewhere in the SRS, or in a separate, specified document.
(2) Identify each document by title, report number - if applicable - date, and publishing organization.
(3) Specify the sources from which the references can be obtained.
This information may be provided by reference to an appendix or to another document.

Reference ID	Document TItle	Version/report	Date	Publisher/source	URL
A	IEEE Std 830-1998: Recommended Practice for Software Requirements Specification	IEEE Std 830-1998	1998	IEEE Computer Society	https://sdsu.instructure.com/courses/178325/files/17281459?module_item_id=4921119
B	Theater	n/a	Summer 2025	Dr. Gus	https://sdsu.in

	Ticketing Requirements Examples			Hanna, SDSU CS 250 (Canvas module)	structure.com/courses/178325/files/17281417?module_item_id=4921121
C	Stripe API Referenced	API v2025-03-15	March 15 2025	Stripe, Inc.	https://docs.stripe.com/api
D	RFC 7519: JSON Web Token (JWT)	RFC 7519	May 2015	Internet Engineering Task Force (IETF)	https://datatracker.ietf.org/doc/html/rfc7519
E	PostgreSQL 13 Documentation	v13	2020	PostgreSQL Global Development Group	https://www.postgresql.org/docs/13/

1.5 Overview

1. The rest of this document will contain design constraints, expectations, requirements, and functionality expected from the system.
2. The document is organized into sections, and those sections into subsections. Every section is labeled with enlarged and bold headers. Every subsection will cover a specific topic that branches out from the main section.

2. General Description

2.1 Product Perspective

Similar ticketing systems have been implemented in many other theaters and adjacent industries. This ticketing system will be catered to our client's needs as opposed to other systems on the market.

2.2 Product Functions

- Handle at least 1000 users at once
- Be able to run in a browser and be accessible both inside and outside theaters
- Handle security of purchases, and block bot attacks that are looking to mass buy tickets

- Interface with existing databases to display available showtimes, and tickets
- Add constraints to purchases: 20 ticket limit per user, availability starting from 2 weeks before showtime, availability ending 10 minutes after showtime
- Support factors in ticket price, such as discounts
- Support an administrator mode for theater staff to handle issues
- Be able to scrape info from review sites online to display movie ratings, reviews, and critic quotes

2.3 User Characteristics

Users will vary highly due to the demographics of theaters spanning almost all ages. Therefore the UI should be highly accessible, and streamlined. The UI should be easy to maneuver for users in both ends of the age range, and for users not tech savvy.

2.4 General Constraints

The ticketing system should be fully functional with touch screen and keyboard input. Additionally, as most ticketing system devices in theaters do not come with a keyboard, a built in onscreen keyboard will be supported.

2.5 Assumptions and Dependencies

It is assumed that devices inside theaters running the ticketing system will have a strong and stable internet connection, and be able to load the application smoothly and quickly. It is also assumed that theater devices will have touch screen support. The devices are also assumed to be able to run Chromium.

3. Specific Requirements

This will be the largest and most important section of the SRS. The customer requirements will be embodied within Section 2, but this section will give the D-requirements that are used to guide the project's software design, implementation, and testing.

Each requirement in this section should be:

- *Correct*
- *Traceable (both forward and backward to prior/future artifacts)*
- *Unambiguous*
- *Verifiable (i.e., testable)*
- *Prioritized (with respect to importance and/or stability)*
- *Complete*
- *Consistent*
- *Uniquely identifiable (usually via numbering like 3.4.5.6)*

Attention should be paid to the carefuly organize the requirements presented in this section so that they may easily accessed and understood. Furthermore, this SRS is not the software design document, therefore one should avoid the tendency to over-constrain (and therefore design) the software project within this SRS.

3.1 External Interface Requirements

3.1.1 User Interfaces

- Optional login screen
  - Inputs: email, password, date of birth
  - Outputs: “Welcome <Name>” banner, or error message.
  - Constraints: Must display on 1920x1080 computer screens and follow respective aspect ratios.
- Movie Listing pages
  - Displays: Movie poster thumbnails, title, showtimes, average ratings
  - Controls: “Select seats” options under each showtime.
- Seat Selection Functionalities
  - Available seats are green, taken seats are red, user-selected seats are gray.
  - Display the row number and position of all seats on hover.
  - Constraints: To prevent multiple users selecting and buying the same seats concurrently, implement first come first serve (e.g. who ever clicked on seats first gets put in “not available” state for 5 minutes amd show gray).

3.1.2 Hardware Interfaces

- Kiosk Touchscreen
  - 10 inch screens that handles capacitive touch (touchscreen). No physical keyboard or mouse.
  - **Driver: TBA**
- Barcode scanner using a mobile camera for scanning printed or digital tickets

3.1.3 Software Interfaces

- Database
  - Type: PostgreSQL 13
- Payment Gateway
  - Stripe REST API v2025-06-30.basil

3.1.4 Communications Interfaces

- Web
  - Protocol: HTTPS

3.2 Functional Requirements

This section describes specific features of the software project. If desired, some requirements may be specified in the use-case format and listed in the Use Cases Section.

3.2.1 <User Authentication>

3.2.1.1 Introduction

- Allows users to register, log in, and log out securely

3.2.1.2 Inputs

- Email (String)
- Password (String)
- Date of birth (Integer)

3.2.1.3 Processing

1. Validate ‘email’ that matches the standard email regex (^[a-zA-Z0-9._%+-]+@[a-zA-Z0-9.-]+\\.[a-zA-Z]{2,}$)

2. For registration: hash ‘password’ to prevent security breaches using bcrypt and store ‘{email, hash}’ in ‘Users’ table in DB.
3. For logging in, retrieve the stored hash for ‘email’ and compare it with bcrypt to ensure authentication.
4. Once logged in, prompt the user to “remember login”. If the user declines, generate a JWT token that expires in 1 hour to terminate the user session.

3.2.1.4 Outputs

- On successful login, output HTTP 200 + JSON
- Json
    - {“userId”: “123”,
    - “name”: “John Doe”,
      “token”: “<JWT>”}

- On unsuccessful login, output HTTP 401 + JSON
- json
    - {“error”: “Invalid email or password, please try again.”}

3.2.1.5 Error Handling

- If email or password is missing, output HTTP 400 + JSON
  json:
    - {“error”: “Email and password required”}

- If server error output HTTP 500 + JSON
  json: {“error”: “Server error, please try again later.”}
    -

3.2.2 <Browsing Shows and Times>

3.2.2.1 Introduction

- After a user successfully logs in, the system will fetch and display current movies and their available showtimes.

3.2.2.2 Inputs

- Session token: JWT token is sent in the HTTP header.
- Date – shows only showtimes on a specific day
- theatreID – show only one theatre’s movie listings.
- searchTerm – text search to look for movie titles.

3.2.2.3 Processing

1. Validate session token and check if user is authenticated.
2. If user changes filters for search, apply them to narrow movie list query
3. Query the movie tables for all movies marked “active” from DB.
4. For each movie, also query Showtimes table for upcoming showtimes alongside current times.
5. Sort by movie name, then showtime chronologically.
6. Format combined data into a response object.

3.2.2.4 Outputs

- On successful completion, outputs HTTP 200.
- Rendered UI: grid of movie listings/titles and clickable showtime buttons.

3.2.2.5 Error Handling

- If session token is missing or invalid, output HTTP 401 unauthorized + json {“error”:

"Authentication required"}
- If a filter is malformed (messed up date format), output HTTP 400 bad request + json {"error": "Invalid date format"}
- If server or database error, output HTTP 500 internal server error + json {"error": "Unable to fetch show data; please try again later."}

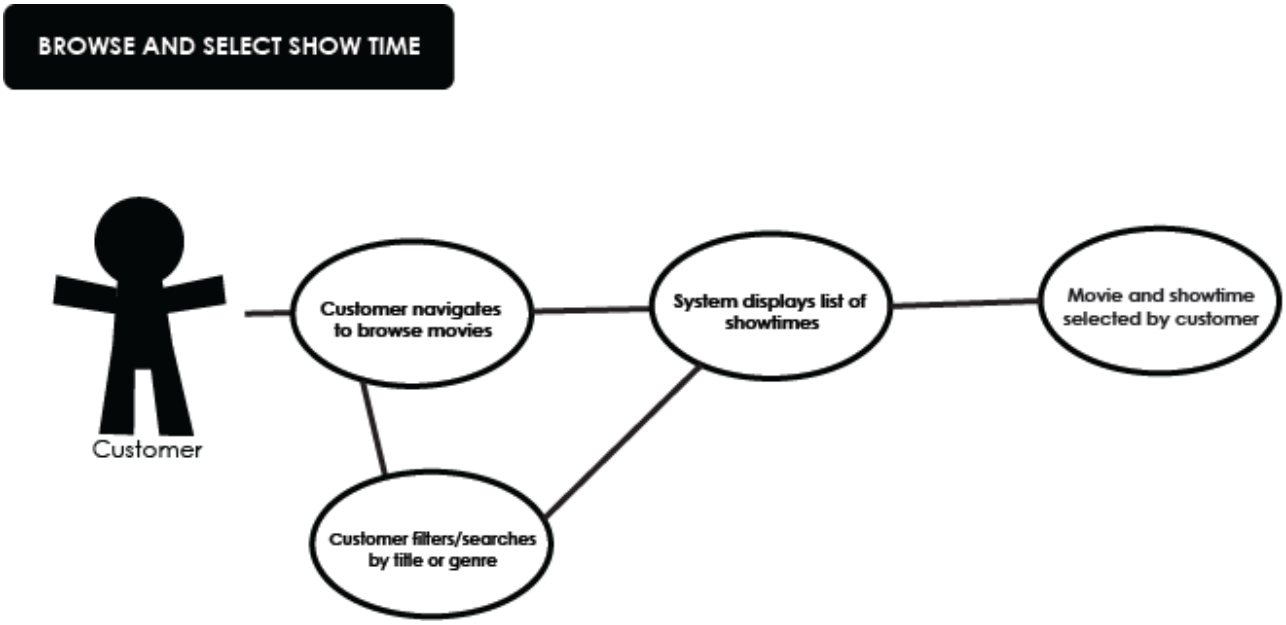
3.3 Use Cases

3.3.1 Browse and Select Showtime

- Actors: Customer.
- Precondition: Customer opens website.
- Post-con: customer selects movie and showtime

MAIN FLOW:

- Customer navigates to browse movies
- System displays list of movies with showtimes and ratings
- Customer filters by theatre and/or time slot
    - Or by title
- System dynamically updates / displays matching results



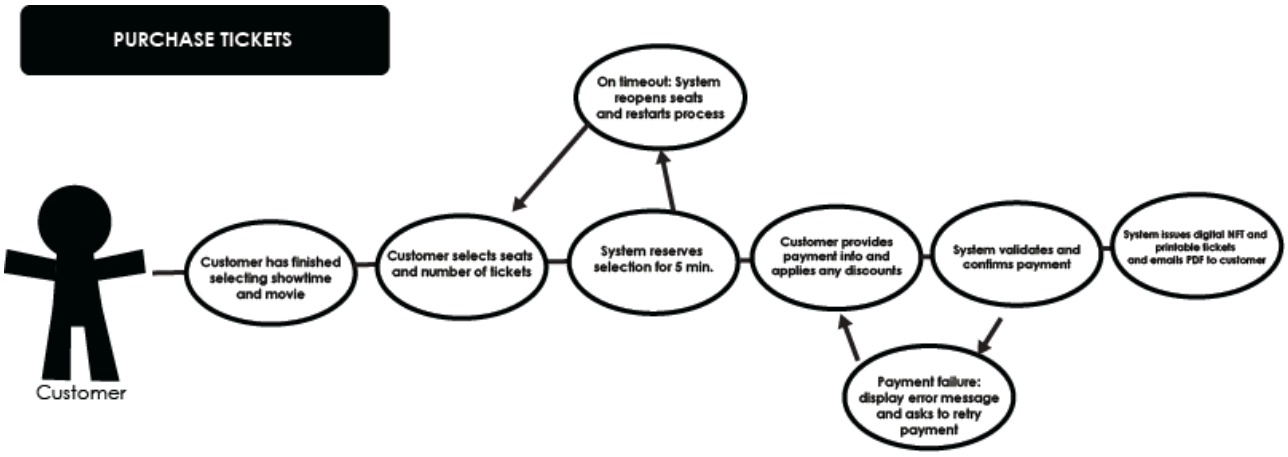
3.3.2 Purchase Tickets

- Actors: customer, payment gateway
- Precon: customer select showtime
- Postcon: tickets confirmed and delivered

MAIN FLOW:

- Customer selects seats and number of tickets
- System reserves selection for 5 min

    - On timeout: System reopens seats and restarts process
- Customer provides payment (and discount if any) info
- System validates payment (using wtv software/security… idk this)
    - On payment failure: system displays error message and asks to retry payment
- System issues digital NFT and printable tickets and emails PDF to customer

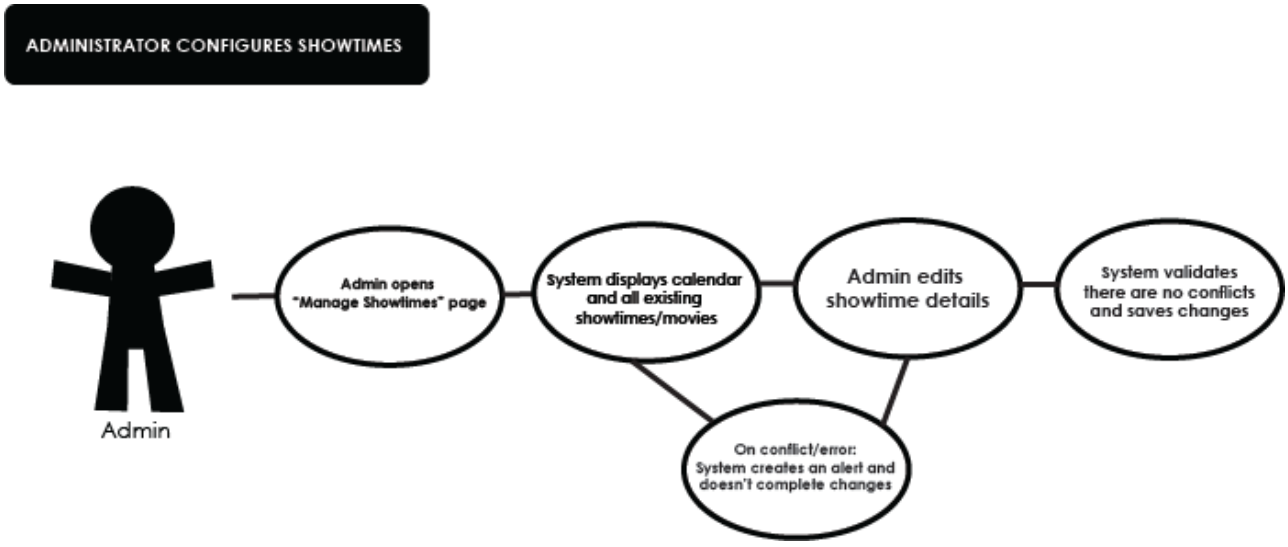


3.3.3 Administrator Configures Showtimes

- Actors: admin
- Precon: admin verified into system
- Postcon: new showtime active

MAIN FLOW:

- Admin opens “Manage Showtimes” page
- System displays calendar and all existing showtimes/movies
- Admin edits showtime details
    - If conflict, system alerts and requires resolving
- System validates if there are 0 conflicts (check first) and saves changes



3.4 Classes / Objects

3.4.1 <Movie>

3.4.1.1 Attributes

- title, rating, duration, reviewScores

3.4.1.2 Functions

- getShowtimes(), getReviews()

<Reference to functional requirements and/or use cases>

3.4.2 <Theater>

3.4.2.1 Attributes

- id, name, location, seatLayout, availableSeats

3.4.2.2 Functions

- getAvailableSeats(showtimeId)

3.4.3 <Showtime>

3.4.3.1 Attributes

- id, movieId, theaterId, startTime

3.4.3.2 Functions

- reserveSeats(), releaseSeats()

3.4.4 <Ticket>

3.4.3.1 Attributes

- id, showtimeId, seatNumber, ticketType, price, nftToken

3.4.3.2 Functions

- generateDigitalTicket(), printPDF()

3.5 Non-Functional Requirements

Non-functional requirements may exist for the following attributes. Often these requirements must be achieved at a system-wide level rather than at a unit level. State the requirements in the following sections in measurable terms (e.g., 95% of transaction shall be processed in less than a second, system downtime may not exceed 1 minute per day, > 30 day MTBF value, etc).

3.5.1 Performance

The process of picking a movie, choosing seating, and purchasing a ticket should be able to be completed within two minutes by users.

3.5.2 Reliability

The system should prioritize reliability and stability because an error in the ticketing system can quickly cause a build up and cause frustration for numerous customers. If all ticketing kiosks were to stop functioning, the theater's performance would severely decline due to their reliance on the ticketing system. The mean time between failures should be around 30 days, and recovery from downtime should be around 10 minutes with assistance from staff.

3.5.3 Availability

Due to the ticketing system running through a browser, it should be available during all times with internet connection.

3.5.4 Security

The main security concern revolves around payments. Stripe API which is being used for handling payments, has built in security features and data encryption for payments. The system should utilize the API properly in order to handle security properly.

3.5.5 Maintainability

The system will be maintained through software updates over the internet when needed. Updates should be relatively quick and be able to be completed before opening hours.

3.5.6 Portability

Because the ticketing system runs through a browser, it should be able to be easily integrated into different locations. Installation and setup shouldn't require more than internet connection.

3.6 Inverse Requirements

*State any *useful* inverse requirements.*

3.7 Design Constraints

Specify design constrains imposed by other standards, company policies, hardware limitation, etc. that will impact this software project.

3.8 Logical Database Requirements

Will a database be used? If so, what logical requirements exist for data formats, storage capabilities, data retention, data integrity, etc.

3.9 Other Requirements

Catchall section for any additional requirements.

4. Analysis Models

List all analysis models used in developing specific requirements previously given in this SRS. Each model should include an introduction and a narrative description. Furthermore, each model should be traceable the SRS's requirements.

4.1 Sequence Diagrams

4.3 Data Flow Diagrams (DFD)

4.2 State-Transition Diagrams (STD)

5. Change Management Process

Identify and describe the process that will be used to update the SRS, as needed, when project scope or requirements change. Who can submit changes and by what means, and how will these changes be approved.

A. Appendices

Appendices may be used to provide additional (and hopefully helpful) information. If present, the SRS should explicitly state whether the information contained within an appendix is to be considered as a part of the SRS's overall set of requirements.

Example Appendices could include (initial) conceptual documents for the software project,

marketing materials, minutes of meetings with the customer(s), etc.

A.1 Appendix 1

A.2 Appendix 2

Theater Ticketing System

Software Design Specification

<Version>

7-29-2025

Group 10
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Prepared for
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Summer 2025

Table of Contents

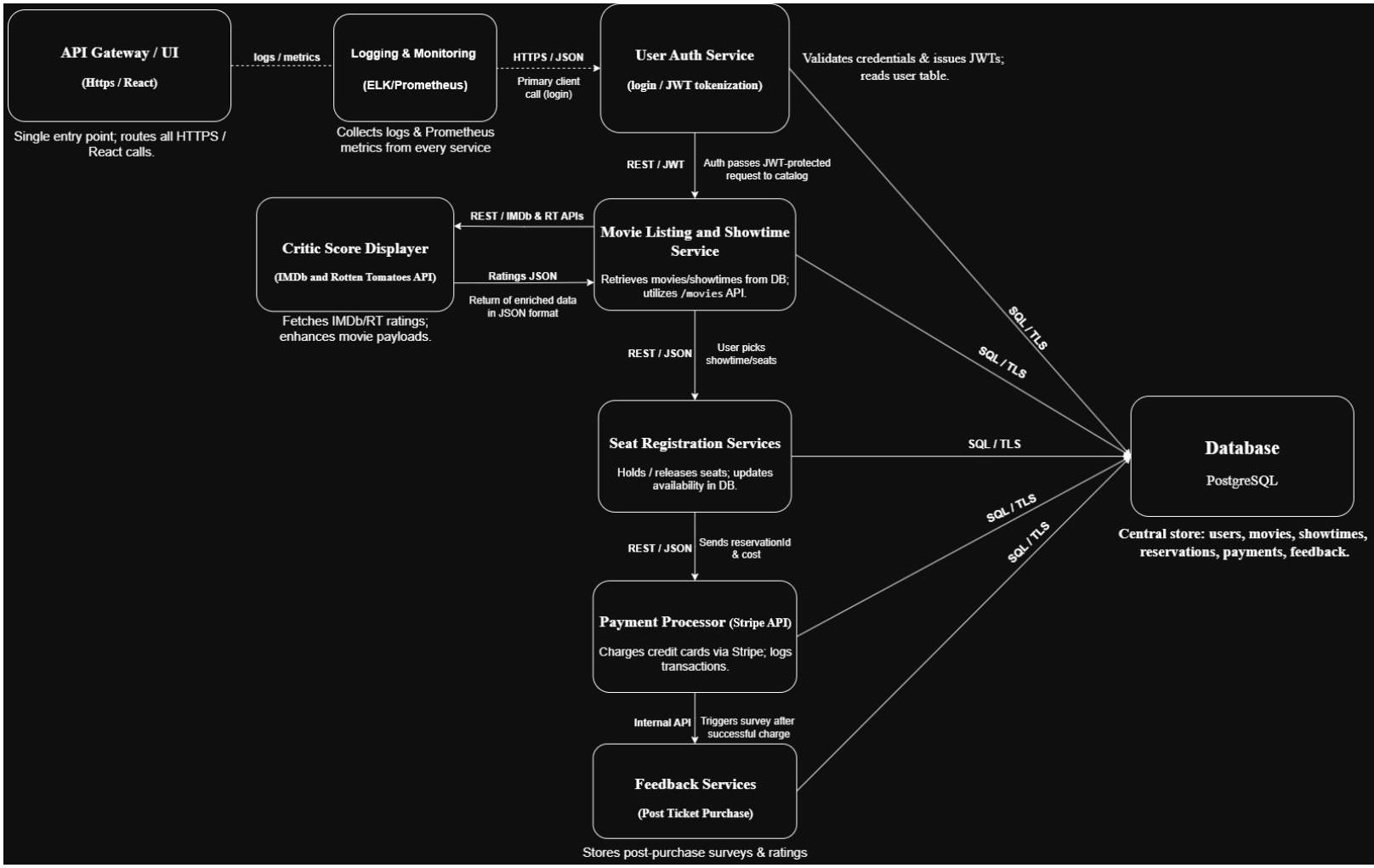
1. System Description

1.1 Overview

All client interactions begin at the API Gateway (HTTPS/React), which routes requests to the User Authentication Service. Upon successful JWT validation (against PostgreSQL), authenticated requests flow into the Movie Listing & Showtime Service, which runs the Critic Score Displayer (IMDb/Rotten Tomatoes API). Seat selection requests are forwarded to the Seat Reservation Service. Once seats are held, the Payment Processor (Stripe API) charges the user and then displays the Feedback Service to capture post-purchase surveys. Finally, each service independently reads from and writes to the central PostgreSQL Database over secured SQL/TLS connections, and all components emit logs and metrics to the Logging & Monitoring stack (ELK/Prometheus) for centralized observability for developers.

2. Software Architecture Overview

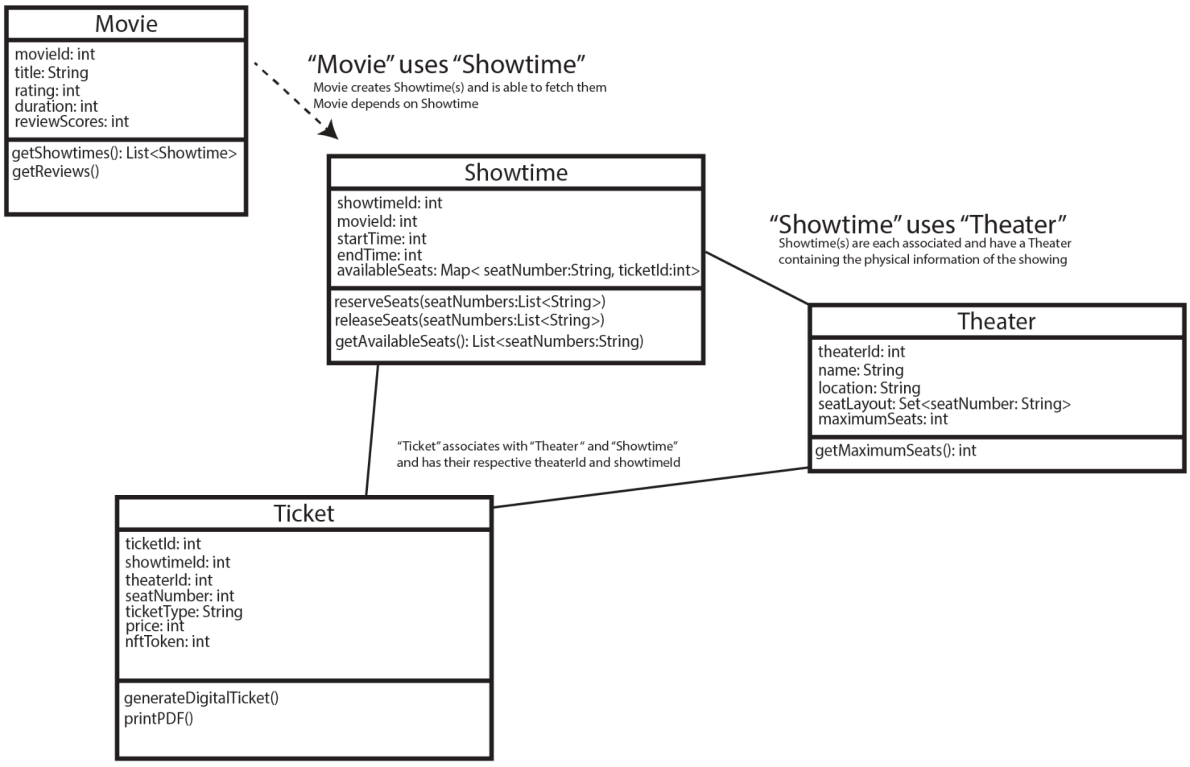
2.1 Architectural Diagram



Link for better viewing:

- https://imgur.com/a/CsHUWkG

2.2 UML Class Design



2.3 Classes / Objects

2.3.1 <Movie>

2.3.1.1 Attributes

- movieId, title, rating, duration, reviewScores
- The attributes contain basic information about the movie.

2.3.1.2 Functions

- getShowtimes(), getReviews()
- The Movie class will create Showtime objects and is able to fetch showtimes for the movie with getShowtimes().

2.3.1.3 Interactions

- When a user selects a movie, the system queries the Movie class using getShowtimes() to pull all upcoming showtimes. These showtimes are then presented alongside their associated theater information.

2.3.2 <Showtime>

2.3.2.1 Attributes

- showtimeId, movieId, startTime, endTime, availableSeats
- The attributes contain info about the movie during the showtime, including the start and end time of the showing.

2.3.2.2 Functions

- reserveSeats(), releaseSeats(), getAvailableSeats()
- Showtime class will also keep track of, and manage available seats.
- Each Showtime class will have a Theater object that contains the information about the physical location of the theater and maximum seating.

2.3.2.3 Interactions

- If a reservation is canceled or times out, releaseSeats() is called to restore availability.
- When a user selects a specific showtime, the system calls getAvailableSeats() to display open seats.
- When the user reserves one or more seats, reserveSeats() is invoked, updating the internal availability map.

2.3.3 <Theater>

2.3.3.1 Attributes

- theaterId, name, location, seatLayout, maximumSeats
- The attributes contain the information about the physical theater, including its location, name, and seating information.

2.3.3.2 Functions

- getMaximumSeats()

2.3.3.3 Interactions

- During Showtime creation, the theater details are linked to ensure the seat layout matches.
- The seat layout is used when generating the availableSeats structure in the Showtime.
- This allows the system to render an accurate seating chart for users.

2.3.4 <Ticket>

2.3.4.1 Attributes

- ticketId, showtimeId, theaterId, seatNumber, ticketType, price, nftToken
- The attributes contain the information about the ticket including information relevant for the consumer such as price, whilst holding information needed for the system such as seating and NFT token.

2.3.4.2 Attributes

- generateDigitalTicket(), printPDF()

2.3.4.3 Interactions

- Once a user completes seat selection and payment, a Ticket object is created.
- The system sets showtimeId and theaterId from the selected Showtime and its linked Theater.
- generateDigitalTicket() might be used to store or display a scannable digital pass, while printPDF() is used for traditional output.
- The nftToken attribute optionally supports blockchain-based verification or collectible features.

2.4 Interaction Flow Example

1. A user selects a movie from a list.
2. The system calls getShowtimes() from the Movie object to display all future showtimes.
3. The user selects a showtime, prompting the system to retrieve associated Theater information and seat layout.
4. The system displays available seats by calling getAvailableSeats() from the Showtime.
5. The user selects a seat and confirms the purchase.
6. The system calls reserveSeats() to lock the seat.
7. Upon payment, a Ticket object is created and linked to the selected Showtime, Theater, and seatNumber.
8. The system calls generateDigitalTicket() or printPDF() to deliver the ticket to the user.

3. Development Plan and Timeline

3.1 Overview

- As stated above, the movie ticketing system will handle the seating and ticket sales for 20 theaters in the San Diego area, and the system will be implemented in devices inside theater lobby areas, allowing customers to easily purchase tickets and choose seating for upcoming showtimes.
- The project development will follow a 16-week, agile-inspired iterative approach.
- The tasks are divided into four-week sprints with key phases including finalization, design, implementation, integration, testing, and deployment.

3.2 Team Roles

- Project Manager: Coordinates the project schedule and communicates with stakeholders.
- UX Designer: Crafts wireframes and prototypes to shape the user experience.
- Backend Engineer: Develops and maintains server-side APIs and business logic.
- Frontend Engineer: Implements client-side functionality and integrates APIs.
- Database Administrator: Designs and optimizes the database schema.
- QA Engineer: Creates test plans and conducts testing to ensure quality.
- DevOps Engineer: Builds and maintains CI/CD pipelines and deployment environments.

3.3 Timeline With Tasks

Task	Description	Roles	Start Week	End Week
Finalize Requirements	Refine and approve all requirements	Project Manager	1	2
UI/UX Design	Create wireframes and high-fidelity mockups	UX Designer	1	4
Database Schema Design	Define logical and physical database schema	Database Administrator	3	5
Backend API Development	Implement core RESTful services (Stripe API)	Backend Engineer	5	8
Frontend Development	Develop web UI components and integrate with APIs	Frontend Engineer	6	9
Integration	Integrate frontend, backend, and external services	Backend Engineer, Frontend Engineer	9	10
Testing and Quality Assurance	Perform unit, integration, and performance testing	QA Engineer	10	12
Deployment and DevOps	Configure CI/CD pipelines and deploy to production	DevOps Engineer	11	13
Pilot Launch	Internal demo and stakeholder feedback collection	Everyone	13	14
Final Release	Address issues and release version 1.0	Everyone	14	16

3.4 Timeline Milestones

- Milestone 1 (Week 2): Wireframes approved (stakeholder sign-off).
- Milestone 2 (Week 5): Schema and API “hello world”; CI green.
- Milestone 3 (Week 8): Seat hold end-to-end works; P95 < 150ms for hold.
- Milestone 4 (Week 11): Payment and webhook idempotency validated.
- Milestone 5 (Week 14): Pilot at one kiosk; rollback plan documented.
- Milestone 6 (Week 16): Release 1.0; ops runbook complete.

4. Test Plan

https://github.com/michaelmpham0/CS250-SRS/tree/main

4.1 Ten Test Cases

Test Case Template							
TestCaseId	**Level**	**Component**	**Priority**	**Test Summary**	**Pre-Requisites**	**Test Steps**	**Expected Result**
TC-U01	Unit	UserAuthenticationService.login();	P1	Valid user login credentials return a JWT token	User record exists in database; "alice"/"pass123"	1. Call login("alice","pass123") 2. Capture return value	Method returns HTTP 200 and a non-empty JWT string
TC-U02	Unit	UserAuthenticationService.login();	P1	Invalid password returns authentication failure	Same user as above	1. Call login("alice","wrongpass") 2. Capture return value	Method will return HTTP 401 Unauthorized with error message
TC-U03	Unit	Showtime.reserveSeats()	P2	Reserving available seats decrements the available count of seats	showtime.availableSeats = 5	1. Call reserveSeats(["A1","A2"]) 2. Call getAvailableSeats() to retrieve count	getAvailableSeats() returns 3
TC-U04	Unit	Showtime.reserveSeats()	P2	Reserving too many seats triggers error	showtime.availableSeats = 1	1. Call reserveSeats(["A1","A2"]) 2. Call getAvailableSeats() to retrieve count	Method throws InsufficientSeatsException error
TC-I01	Integration	Auth --> Catalog REST flow	P1	Login + fetch showtimes returns correct list	Valid JWT token	1. POST /auth/login --> get token 2. GET /movies with Authorization: Bearer <token>	HTTP 200 + JSON array of active movies with showtimes
TC-I02	Integration	Reservation --> Payment REST flow	P1	Reserving seats then charging via Stripe logs transaction	User authenticated; seats available	1. POST /reserve with seat array 2. POST /payment with reservationId and valid card details	HTTP 200 for both calls; DB contains matching reservation and payment records
TC-S01	System	End-to-end purchase flow (UI)	P1	User logs in, selects seats, pays, and receives ticket	Browser automation tool configured (Cypress)	1. Navigate to login page, enter creds 2. Select movie & showtime 3. Pick seats 4. Enter payment info 5. Submit and await email/PDF	Final page shows "Purchase Complete"; user email receives PDF ticket
TC-S02	System	Feedback prompt after purchase	P2	After successful order, survey modal appears	TC-S01 completed	1. Complete end-to-end purchase as above 2. On Confirmation page, wait for survey popup	Survey dialog appears with rating and comments fields for user to input; info sent back to db
TC-E01	Error/Boundary	PaymentProcessor.charge() error handling	P1	Declined card yields proper rollback	Valid reservationId; Stripe returns "card_declined"	1. Call /payment with reservationId and expired card number	HTTP 402 Payment Required; Reservation status reset in DB
TC-E02	Error/Boundary	Concurrent seat reservation conflict	P1	Two users reserving same seat; one should fail	Two auth tokens for users U1 and U2; seat available	1. U1 calls reserveSeats(["B5"]) 2. U2 concurrently calls reserveSeats(["B5"])	U1 succeeds (HTTP 200), U2 receives HTTP 409 Conflict with "Seat already reserved" error message

- Luis Michael Anh CS 250 Test Cases

Secondary link for backup:

- https://docs.google.com/spreadsheets/d/17utWTGSj21sFyR-Cfx1zLdRXUCRtj4oB113XLD3n7E/edit?gid=154441850#gid=154441850

4.2 Updated Design Specification

- Additional changes were made to the UML class description since Assignment 2.
- Interactions between the classes and the flow of the system was expanded upon.
- Our existing classes (Movie, Showtime, Theater, Ticket) and their functions remain suitable for all planned tests.

4.3 Test Plan Overview

- This Test Plan defines how we will verify that each class and API behaves as specified, and validate by exercising full end-to-end purchase flows.
- We will cover three levels of testing: unit, integration, and system, to achieve

comprehensive coverage.

4.4 Test Strategy and Target Components

5. Data Management Strategy

5.1 Persistence Layer Overview

The Movie Theater Ticketing System uses a single centralized PostgreSQL relational database as the authoritative store for all core domain data: users, theaters, movies, showtimes, reservations, tickets, payments, feedback, and audit logs. PostgreSQL was chosen for its strong ACID guarantees, straightforward integrity, and native transactional support, which are critical for maintaining consistency in seat allocation and payment flows. External data such as critic scores from IMDb and Rotten Tomatoes are fetched on demand and are not persisted long-term; they may be cached in future iterations for performance but are currently retrieved directly to avoid stale data issues. Payment processing is supported by Stripe and raw card details are never stored. Only transaction references and statuses are kept in the database.

5.2 Logical Schema

The logical schema models the key business objects and their relationships, enforcing integrity through foreign keys and unique constraints. These primary keys are:

- **User:** Represents a customer or administrator, with hashed authentication credentials.
- **Movie:** Title, metadata, duration, and associated information.
- **Showtime:** A scheduled screening of a movie at a particular theater, tracking available seats.
- **Seat / SeatAssignment:** Represents individual seats tied to a specific showtime to manage availability.
- **Reservation:** A user's intent to hold one or more seats for a showtime; linked to User and Showtime.
- **Ticket:** Issued after successful payment, referencing a Reservation and specific Seat(s), including price and unique identifiers.
- **Payment:** Records payment attempts and confirmations, associated with Reservations.
- **Feedback:** Post-purchase survey responses tied to Tickets or Reservations.
- **AuditLog:** Captures critical system actions (reservations, payments, overrides) for accountability and error troubleshooting.

These keys are related to ensure that, for example, a reservation cannot exist without a valid user and showtime, and a ticket is only created after a successful, consistent reservation/payment pair. Constraints prevent double assignment of the same seat for a showtime.

5.3 Consistency and Concurrency Controls

To avoid double-booking and ensure atomicity between reservations and payments, critical operations like reserveSeats() are wrapped in database transactions. Row-level locking is used on seat availability records so that concurrent attempts to reserve the same seat are either serialized or fail cleanly. If payment processing fails, the transaction rolls back, releasing held seats automatically for other users to book. This design allows for consistency for the core purchase flow, guaranteeing that seat state and corresponding financial records remain in order.

5.4 Security and Sensitive Data Handling

Security and privacy are fundamental given the persistence of user and financial data. Important practices include:

- **Authentication:** User credentials are stored as salted, hashed values (e.g., bcrypt) to prevent compromise of plaintext passwords.

- **Payment Data:** All payment card handling is offloaded to Stripe; no raw card data is stored, which reduces PCI-DSS exposure. Only tokens or transaction references and statuses are retained.

- **Encryption in Transit:** All service-to-service and client communications use TLS/HTTPS to protect data while moving across the network.

- **Encryption at Rest:** The database is assumed to reside on encrypted storage (e.g., disk-level encryption provided by infrastructure) to secure data at rest.

- **Access Controls:** Role-based access ensures that administrative actions (overrides, refunds) are restricted and logged.

- **Audit Logging:** Critical events such as reservation creation, payment success/failure, and admin interventions are recorded to support accountability, auditability, and incident investigation.

- **PII Protection:** Personally identifiable information (for example, email addresses) is accessed only by authorized subsystems and is subject to logging and minimal exposure.

5.5 Scalability and Performance

Currently, the system uses only a single PostgreSQL instance without a dedicated caching layer or read replicas. All consistency-critical reads (such as seat availability) query the primary database directly to avoid stale views. Some of the future enhancements that our group and I thought about are:

- **Caching**: For non-critical, read-heavy data like movie metadata or frequently viewed showtime summaries, a cache could reduce load and improve user response time while carefully avoiding stale consistency for seat state.
- **Read Replicas**: Introducing read replicas could offload read traffic (e.g., browsing listings) from the primary, accepting eventual consistency for those views while keeping writes strictly on the master.

5.6 Backup, Recovery, and Retention

Automated daily backups of the PostgreSQL database are performed to ensure recoverability. Backups are kept for a 14-day window to allow point-in-time recovery from recent data corruption or failure. Audit logs and feedback data are retained for 90 days due to their importance in diagnostics. Periodic recovery drills (e.g., monthly) are conducted to verify the integrity of backups and validate that restoration procedures function as expected.

5.7 Alternatives and Tradeoffs

Some design alternatives that were discussed:

- **NoSQL Document Store:** A document-oriented database like MongoDB would simplify storing nested reservation/ticket structures and scale horizontally, but would complicate enforcing relational constraints (preventing double-booked seats) without more elaborate patterns.

Our current choice, a single normalized PostgreSQL store, favours strong consistency, simplicity in development and testing, and reliable transactional guarantees. The tradeoff that we can think of is that under a significant future load, more sophisticated scaling mechanisms will be needed to mitigate contention and read/write pressure.