**🏨 Hotel Booking System – Technology Stack & Architecture**

**📘 Project Overview**

A **full-stack hotel booking platform** featuring **AI-powered capabilities**, **real-time updates**, and **comprehensive user management**.  
Designed for scalability, performance, and modern user experience.

**⚙️ Backend Technologies**

**Spring Boot 3.x (Java 17)**

* **Why:** Enterprise-grade framework with an excellent ecosystem
* **Benefits:** Auto-configuration, embedded server, production-ready features
* **Use Case:** RESTful API development, dependency injection, and security integration

**Spring Security + JWT**

* **Why:** Industry-standard authentication and authorization
* **Benefits:** Stateless authentication and role-based access control
* **Implementation:**
  + JWT tokens for secure API access
  + Password encryption using BCrypt

**Spring Data JPA + Hibernate**

* **Why:** Simplifies database operations using ORM
* **Benefits:** Automatic query generation, relationship mapping, transaction management
* **Models:** User, Hotel, Room, Booking, Payment, Review

**H2 Database (Development) + Multi-DB Support**

* **Why:** In-memory database for rapid development and testing
* **Production Ready:** Supports MySQL, PostgreSQL, SQL Server migration
* **Benefits:** Zero setup, auto schema generation, easy initialization

**Maven**

* **Why:** Reliable dependency management and build automation
* **Benefits:** Standardized project structure, plugin ecosystem, lifecycle management

**💻 Frontend Technologies**

**React 18**

* **Why:** Component-based UI framework with modern hooks
* **Benefits:** Virtual DOM, reusable components, large ecosystem
* **Features:** Functional components, custom hooks, context API

**Redux Toolkit**

* **Why:** Predictable and centralized state management
* **Benefits:** Time-travel debugging, middleware support
* **Implementation:** Manages auth, hotel, and booking state

**React Router**

* **Why:** Enables client-side routing for a single-page app
* **Benefits:** Dynamic routing, protected routes, nested navigation
* **Features:** Role-based route protection

**Axios**

* **Why:** HTTP client with interceptors and response transformation
* **Benefits:** Automatic JSON parsing, error handling, request cancellation
* **Implementation:** API service layer with authentication headers

**CSS3 + Modern Styling**

* **Why:** Clean, responsive, and interactive design
* **Benefits:** Responsive layouts, animations, gradients
* **Features:** Flexbox, Grid, CSS variables, media queries

**🤖 AI & Advanced Features**

**Google Gemini AI Integration**

* **Why:** Leverages NLP and AI for customer support
* **Benefits:** Context-aware, intelligent responses
* **Implementation:**
  + AI chatbot for customer queries
  + AI-generated emails
  + Role-based AI responses (Customer/Admin)

**WebSocket Integration**

* **Why:** Real-time communication between clients and server
* **Benefits:** Instant updates and live synchronization
* **Features:** Price updates, booking notifications, availability changes

**Email Service with AI Enhancement**

* **Why:** Automated and personalized communication
* **Benefits:** AI-generated content with HTML templates
* **Implementation:** Booking confirmations, welcome emails, cancellations

**🧱 Architecture Patterns**

**RESTful API Design**

* **Why:** Standardized, predictable, and stateless design
* **Benefits:** Uniform interface and scalability
* **Implementation:** CRUD operations with proper HTTP codes and JSON responses

**Repository Pattern**

* **Why:** Separation of concerns between data and logic
* **Benefits:** Testability, maintainability, database independence
* **Implementation:** Custom JPA repositories

**DTO Pattern**

* **Why:** Secure and efficient data transfer
* **Benefits:** Field filtering, validation, API versioning
* **Implementation:** Request/Response DTOs for each endpoint

**Service Layer Architecture**

* **Why:** Separate business logic from controllers
* **Benefits:** Reusability, testability, single responsibility
* **Implementation:** UserService, BookingService, HotelService, PaymentService

**🔒 Security Features**

**JWT Authentication**

* **Why:** Stateless and scalable authentication
* **Benefits:** No session storage, cross-domain compatibility
* **Implementation:** Role-based access control

**CORS Configuration**

* **Why:** Enable secure frontend-backend communication
* **Benefits:** Controlled cross-origin access
* **Implementation:** Custom CORS policy per environment

**Password Encryption**

* **Why:** Secure password handling with BCrypt
* **Benefits:** Salt-based hashing, configurable strength

**🚀 Development & Deployment**

**Environment Configuration**

* **Why:** Separate dev, test, and prod environments
* **Benefits:** Secure and flexible setup
* **Implementation:** application.yml, .env files, and profiles

**Data Initialization**

* **Why:** Auto-load sample data for testing
* **Benefits:** Quick setup, demo-ready environment
* **Implementation:** DataInitializer with mock hotels, users, and bookings

**Multi-Database Support**

* **Why:** Flexibility for deployment across platforms
* **Benefits:** H2 (dev), MySQL/PostgreSQL/SQL Server (prod)
* **Implementation:** Configurable JPA setup

**🌟 Key Features Implemented**

**User Management**

* Registration/Login with JWT
* Role-based access (Customer/Admin)
* Profile management with avatars
* Secure password storage

**Hotel & Room Management**

* Hotel search and filtering
* Real-time room availability
* Dynamic pricing
* Image management

**Booking System**

* Real-time availability checks
* Secure payment integration
* Booking history and management
* AI-powered email confirmations

**Admin Dashboard**

* Manage hotels, rooms, and users
* Monitor bookings and transactions
* Role-based administration

**AI-Powered Features**

* Intelligent chatbot
* AI-generated emails
* Context-aware support

**Real-Time Updates**

* WebSocket notifications
* Live price and booking updates
* Instant confirmations

**🏁 Conclusion**

This technology stack delivers a **robust, scalable, and modern** hotel booking management solution — powered by **AI integration**, **real-time updates**, and **enterprise-level security**.