

U.S. Dental Insurance System

1. Introduction

The **Advanced U.S. Dental Insurance System** is a role-based, enterprise-level web application that simulates **real U.S. dental insurance operations**, similar to leading providers such as **Delta Dental**, **Humana**, **MetLife**, and **Guardian**.

The system manages:

- Dental insurance plan creation
- Support for **PPO / HMO / Discount / Premier** plan types
- In-network & out-of-network dentist handling
- Patient enrollment
- CDT-coded procedures
- Dentist treatment submissions
- Claim calculation using actual U.S. dental insurance rules
- Deductible, coverage %, and annual maximum tracking
- Provider network directory (Find-a-Dentist)
- Cost Estimator tool
- Dashboards for all user roles

The project is built using:

Spring Boot, **JPA/Hibernate**, **Spring Security JWT**, **MySQL**, and follows a multi-layer architecture.

2. Project Objectives

1. Provide a realistic simulation of U.S. dental insurance operations.
2. Implement **role-based authentication** (Admin, Dentist, Patient).
3. Automate dental insurance claims using U.S. billing logic:

- CDT codes
- Deductibles
- Annual Maximum Rules
- Coverage tiers (Preventive / Basic / Major)
- Network-based pricing

4. Provide dashboards for Patients, Dentists, and Admins.

5. Include advanced insurance tools (Cost Estimator, Provider Directory).

6. Build a scalable, modular architecture suitable for enterprise use.

3. System Architecture

A layered architecture ensures clean separation of concerns.

3.1 Presentation Layer

- REST Controllers (Admin, Patient, Dentist)
- DTOs for user input and responses
- JWT Authentication filter

3.2 Service Layer

- Business logic for:
 - Plan rules
 - Claim calculation engine
 - Deductible enforcement
 - Annual maximum enforcement
 - Network fee adjustment
- Cost estimator engine

3.3 Data Access Layer

- JPA repositories
- MySQL Database
- Entities for all insurance models

3.4 Security Layer

- Spring Security + JWT
 - Role-based access control
 - BCrypt password hashing
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4. Insurance Plan Types (U.S. Standard)

To match real systems (Delta Dental, MetLife), the platform supports:

Plan Type	Description
PPO (Preferred Provider Organization)	Large network; patient may visit out-of-network dentists at higher cost. Deductibles + annual max apply.
HMO / DHMO (Dental Health Maintenance Organization)	Patient must select a Primary Dentist. No out-of-network coverage. Usually no deductibles.
Premier / Fee-For-Service	Largest network, flexible coverage, typically higher premiums.
Discount Plan (Savings Plan)	Not insurance. Dentist gives discounted rates. No claims, no deductibles.

Each plan contains:

- Deductible
 - Annual Maximum
 - Coverage tiers
 - Premium
 - Waiting period (optional)
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5. Coverage Structure (U.S. Standard)

Dental insurance uses three categories:

Category	Examples	Typical Coverage
Preventive	Cleaning, X-rays	100%
Basic	Fillings, Simple extractions	70-80%
Major	Crowns, bridges, dentures	40-50%

Premium plans may add:

- Orthodontics (braces)
 - Implant coverage
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6. Provider Network Module (Delta Dental Style)

A dentist can belong to:

- **IN_NETWORK (Contracted)**
 - Lower negotiated fees (MPA – Maximum Plan Allowance)
 - No balance billing
 - Higher insurance coverage
- **OUT_OF_NETWORK**
 - Dentist charges standard fees
 - Insurance covers less
 - Patient pays more

Fee Calculation Example:

Procedure Fee: \$1000

In-network allowed amount (MPA): \$650

Insurance covers 50% → \$325

Patient pays: 325

7. System Features by User Role

7.1 PATIENT FEATURES

1. Register / Login (JWT)
2. View available plans (PPO/HMO/Discount)
3. Enroll in plan

4. View Benefit Summary

- Deductible remaining
- Annual max remaining
- Coverage %

5. View dentist directory (Find-a-Dentist)

6. Cost Estimator Tool

7. View claims

8. Submit a claim (if dentist does not submit)

9. View treatment history (CDT-coded)

7.2 DENTIST FEATURES

1. Login using dentist role

2. Add CDT procedures with fees

3. Submit treatment claims

- Select patient
- Select CDT code

4. View claim calculation results

5. View all claims submitted

7.3 ADMIN FEATURES

1. Admin Login

2. Create/Edit Plans (PPO, HMO, Discount)

3. Manage coverage rules

4. Create/Approve dentists

5. View all patients & plan enrollments

6. Claims queue

7. Reports & Analytics

- Total claims
 - Total payouts
 - Plan performance
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8. Additional Realistic Modules

8.1 Find-A-Dentist Module

Search dentists by:

- ZIP Code
- City / State
- Specialty
- Network Type (PPO, HMO, Premier)

Result shows:

- Dentist Name
 - Address
 - Network status
 - Accepted plans
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8.2 Cost Estimator Tool

Input:

- CDT code
- Dentist (in/out network)
- Patient plan

Output:

- Procedure fee
- Allowed amount (MPA)
- Insurance portion
- Patient portion
- Deductible applied

This matches real U.S. dental insurance apps.

9. Claim Calculation Engine

This is the core of your application.

Steps:

1. **Read the CDT procedure category**
2. **Apply network fee rule (in-network vs out-of-network)**
3. **Apply deductible**
4. **Apply coverage % based on category**
5. **Apply annual maximum**
6. **Generate EOB (Explanation of Benefits)**

Example:

Total Fee: \$1200

Allowed Amount (In-network): \$900

Deductible (if remaining): \$50

Remaining Allowed: \$850

Coverage: 50% → \$425

Annual Max remaining: \$1000 → Enough

Insurance Pays: \$425

Patient Pays: Fee - Insurance: \$775

Enrollment table updated:

deductibleUsed = 50

annualMaxUsed = 425

10. End-to-End Workflow

Step 1 – Admin Creates Plan

(With coverage, deductible, network fees)

Step 2 – Patient Enrolls

Creates Enrollment (benefit year)

Step 3 – Dentist Submits Claim

Selects patient + CDT code

Step 4 – System Calculates

Applies deductible, coverage, annual max

Step 5 – Patient Views EOB

Insurance paid vs patient responsibility

11. Dashboards

11.1 Patient Dashboard

- Plan details
- Remaining benefits
- Claim history
- Dentist directory
- Cost estimator

11.2 Dentist Dashboard

- Add CDT procedures
- Submit claims
- View past claims

11.3 Admin Dashboard

- Plans
- Providers

- Patients
 - Claims
 - Analytics
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12. Database Design (High-Level)

Entities:

- User
 - Role
 - Patient
 - Dentist
 - DentalPlan
 - ProcedureCategory (Preventive/Basic/Major)
 - DentalProcedure (CDT)
 - Enrollment
 - Claim
 - ClaimLine
 - ProviderNetwork (In/Out network)
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13. Security Module

- Spring Security
- JWT Token generation
- Authentication filter
- Role-based authorization
- BCrypt hashing

Endpoint protection:

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/admin/** → ADMIN  
/dentist/** → DENTIST  
/patient/** → PATIENT
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14. Technology Stack

Layer	Technology
Backend	Spring Boot
ORM	JPA / Hibernate
Security	Spring Security + JWT
Database	MySQL
Frontend	JSP / React (optional)
Tools	STS / IntelliJ, Postman