Enterprise HR Portal: A Project Report

A Project Report
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ABSTRACT

[Enterprise HR Portal]

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Enigma HR Solutions is a modern full-stack HR management portal that combines an Angular single-page UI with a Node.js + Express API and a self-populating MySQL datastore, all protected through Auth0's OIDC code-flow SSO and JWT-based role-based access control for HR, manager and employee personas. The app drives first-time Auth0 login synchronizations into employees table with frictionless identity-to-record mapping and offers full-strength, permission-sensitive CRUD operations, onboarding-by-seconds response and interactive dashboards that surface head-count, salary and team-structure analytics. Scalability and user experience are ensured through server-side pagination and lazy-loaded search that remain UI payloads tiny even with enormous datasets, while a single real-time notification centre ensures users never miss a critical alert or task. Continuous integration and delivery are automatically done through a Dockerised Jenkins pipeline triggered by GitHub webhooks and securely made available through ngrok, giving reproducible builds and push-to-deploy feedback at minute-levels. All of these pieces demonstrate how open-source technologies and cloud identity services can offer enterprise-class HR capabilities at low operational weight, giving a scalable template that can be extended to predictive analytics and compliance tooling and mobile clients.

Acknowledgements

We would like to extend our sincere thanks to all those who assisted us in successfully finishing the Enigma HR Solutions project.

Above all, we would like to extend our deepest thanks to Professor Andrew Bond for his untiring encouragement, insightful guidance, and professional advice during the process of creating this project. His insightful feedback and mentorship have contributed significantly to guiding both our technical journey and professional growth. Professor Bond's unrelenting passion for collaborative learning has enhanced our learning experience immensely in the CMPE-272 Spring 2025 course.

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Vijaya Sharavan Reddy Baddam - For effective integration of the security framework and authentication mechanisms

Jahnavi Kedia - For designing and evolving the frontend user interface with great care to user experience

Divyasri Lakshmi Alekhya Nakka - For handling the project management and quality assurance activities

Bhaskara Venkata Ramana Garbham - For carrying out the API infrastructure and system integration activities

All the members have worked with unbelievable technical knowledge, willpower, and team spirit and have contributed equally and importantly to the success of the project. The cross-functional knowledge in our team has enabled us to work effectively on challenges and deliver a complete HR solution.

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Finally, we would like to thank the open-source community whose tools, libraries, and frameworks have been at the heart of our implementation work.

This project is not just a culmination of our technical expertise but a testimony to the power of productive collaboration and dedicated team effort.

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Chapter 1. Introduction

1.1 Project goals and objectives

- Create a cutting-edge, full-stack HR portal that consolidates daily HR operations and employee data into a single web application.
- Give HR, managers, and staff enterprise-grade security by implementing JWT validation, Auth0 single sign-on (OIDC code flow), and fine-grained role-based access control.
- To cut down on manual labor and expedite decision-making, implement productivity features like analytics dashboards, real-time notifications, server-side pagination, and quick-action onboarding.
- Ensure quick, dependable releases by automating the software-delivery pipeline with a Jenkins-based **CI/CD** workflow that is started with each GitHub push.
- By using **Auth0 SSO** to secure the Jenkins CI/CD instance, you can enforce end-to-end **RBAC** by limiting access to pipelines to authorized roles.
- By integrating social-login connectors for GitHub and Google, developers can sign in using their pre-existing accounts, reducing onboarding friction. .

1.2 Problem and motivation

Conventional HR teams manage several separate tools for communication, analytics, employee records, and authentication. This leads to:

Pain-point	Impact on HR teams
Disparate login systems	Security risks and poor user experience
Manual data entry & duplication	Inconsistent records, wasted effort
Limited self-service & visibility	Managers lack real-time workforce insight
Slow release cycles	New features/fixes take weeks to reach users

By combining analytics, data storage, and authentication into a single, cloud-ready stack, Enigma HR fills these gaps. Users logging in using Auth0 but not being listed in the MySQL employees table was a major early problem that fueled HR-only enrichment workflows and automatic first-login synchronization logic. Using **OIDC SSO** bridges the security gap and harmonizes pipeline access with corporate identity policies, as traditional Jenkins configurations depend on local accounts or shared tokens. Developer adoption was slowed by the creation of manual credentials; social login reduces time-to-first-commit and automates identity verification.

1.3 Project application and impact

- **Organisation-wide SSO portal** – one URL and one identity for employees, HR and managers.
- **Secure employee directory & self-service profiles** give staff up-to-date records while protecting edits behind HR privileges.

- **Interactive dashboards** surface head-count, hiring churn and salary trends for data-driven HR strategy.
- **Real-time notification centre** keeps stakeholders aligned on onboarding tasks, policy changes and approvals.
- **Business impact:** faster onboarding, fewer security incidents, richer workforce insights and lower licence spend versus buying multiple point tools.
- Secure CI/CD boosts audit readiness and prevents unauthorised code promotion, directly **improving release integrity**.
- Seamless Google/GitHub sign-in has **lowered support tickets and accelerated contributor ramp-up**, translating to faster feature throughput.

1.4 Project results and expected deliverables

Deliverable	**Description**	**Status**
Source code	**Node + Express API, Angular UI, MySQL schema**	**Complete**
Auth0 integration layer	**OIDC flow, JWT verification & RBAC middleware**	**Complete**
Employee-management module	**CRUD, search, server-side pagination**	**Complete**
Analytics & dashboards	**Head-count, salary, quick-action widgets**	**Complete**
CI/CD pipeline	**Dockerised Jenkins, GitHub webhook, ngrok exposure**	**Complete**

1.5 Market research

North America holds approximately 34% of the global HR management software market, which is estimated to be worth ≈ USD 18.4 billion in 2024 and is expected to grow at a compound annual growth rate of 11.8% to reach ≈ USD 56 billion by 2034. Tighter data-protection regulations and growing demand for cloud-based, AI-enhanced HR tools highlight the commercial value of safe, integrated solutions like Enigma HR. According to industry surveys, developer-friendly social logins and SSO-secured pipelines are top priorities for contemporary DevOps teams; our solution **reflects the best practices** outlined by Auth0's reference architecture.

1.6 Project report Structure

This report is organized into seven chapters:
Chapter 1 introduces the project goals, motivation, and expected outcomes
Chapter 2 provides background information and related work
Chapter 3 details the system requirements and analysis
Chapter 4 explains the system design approach
Chapter 5 covers the implementation details
Chapter 6 describes testing methodologies and results
Chapter 7 concludes the report and suggests future enhancements

Chapter 2 Background and Related Work

2.1 Background and used technologies

Enigma-HR was designed to replace disjointed HR point tools with a single full-stack web-based application that managers, HR personnel, and employees can access via one identity provider. A contemporary yet well-known stack is used to construct the solution:

- Backend – Backend: A lightweight REST API layer that is simple to extend and containerize is offered by Node.js and Express.
- Database – Normalized employee, salary, and role tables are stored in the MySQL database, which is initialized upon server startup.
- Frontend – Angular uses the REST endpoints and provides a one-page experience.
- Security – A fine-grained role-based access-control model (HR, manager, and employee) protects sensitive routes, and Auth0 manages SSO using the OpenID Connect (OIDC) authorization-code flow. Issued JWTs are validated on each request.
- DevOps – GitHub web-hooks initiate a Dockerized Jenkins CI/CD pipeline, and ngrok TLS tunneling ensures that builds are safely made available online.
- The team's objectives of quick development, simple scaling, and enterprise-grade security without requiring an on-premises identity service are reflected in these decisions.
- Jenkins (automation), Auth0 (SaaS OIDC), Google & GitHub OAuth apps, plus Angular, Node.js, MySQL

2.2 State-of-the-art
The project adopts current best practices that appear predominantly in leading commercial HR suites:

Capability	**Implementation in Enigma-HR**	**Why it is "state-of-the-art"**
Zero-trust SSO & OIDC	Auth0 integration with PKCE + authorization-code flow	Outsources complex identity management while meeting modern security standards
Fine-grained RBAC	Middleware checks JWT scopes before every CRUD action	Mirrors security models in Workday and SAP SuccessFactors, keeping least-privilege by design
Server-side pagination & lazy search	Backend slices results and frontend requests only visible pages	Same optimization pattern used by large-record HRIS to keep UI latency low on slow networks
Real-time notification centre	Pushes alerts instantly to a unified inbox	Promotes responsive HR workflows similar to Microsoft Viva Connections
Automated CI/CD with Docker	Jenkinsfile builds, tests and deploys both Angular and Node images on every commit	Continuous delivery shortens release cycles to hours instead of weeks,

		aligning with DevOps research benchmarks.

Together these elements place Enigma-HR on par with contemporary SaaS HR platforms while remaining fully open for custom extensions.

2.3 Literature survey

Although Enigma-HR is an original build, its design draws heavily on established research, standards and industry guidance referenced throughout the PDF:

- OpenID Connect & OAuth 2.0 – The security architecture of OpenID Connect & OAuth 2.0 adheres to the token validation procedures and flows suggested in the Auth0 OIDC white paper and associated IETF RFCs. This is evident in the slide walkthrough of every redirect and token exchange.
- Role-Based Access Control (RBAC) – The permission model provides specific role-operation matrices that are displayed in the project's "Role-Based Access Control" slide, and it is modeled after the NIST RBAC framework.
- Scalable Data-grid Patterns – Under "Performance Optimizations," server-side pagination and lazy search adhere to patterns outlined in large-dataset user interface literature.
- Continuous Delivery – The "CI/CD Integration Summary" slide shows how the Jenkins pipeline demonstrates automated build, test, and deploy stages by implementing best practices from the DevOps Research & Assessment (DORA) reports.
- Human-Capital Analytics –Interactive dashboards that display trends in headcount, churn, and salary reflect metrics that have been found to be essential for evidence-based workforce planning in HR analytics research.
- The security advantages of this architecture are further supported by recent white papers on "Zero-trust DevOps" and the documentation for Auth0's Jenkins OIDC plugin (see the Auth0 & Jenkins documents cited in the PDF).

Chapter 3: System Requirements and Analysis

3.1 Domain and Business Requirements

Our application Enigma HR Solutions is designed to handle the latest needs of the Human Resource (HR) departments in big organizations. The system focuses on simplifying employee management, automating HR workflows, enabling secure role-based access, and also offering analytics of the employee data . The major business goals are listed below:

- Streamlining of employee onboarding and profile management processes.
- Restrict sensitive actions only to HR roles.
- Facilitate secure Single Sign-On (SSO) using identity providers.
- Feature to give real-time announcements through notifications.
- Analytical dashboards to support HR personnel’s decision making.
- Team hierarchy to browse employees in the current team.

3.2 Customer-Oriented Requirements

From an end-user view, the application must:

- Enable employees to view and manage their own basic profile data.
- Enable HR role users to create, update, or delete employee data securely.
- Provide managers with access to their team structure.
- Ensure a smooth login experience using Auth0 SSO.
- Offer an intuitive and responsive UI built with Angular.
- Send real-time notifications and updates.

3.3 System Function Requirements

The system focuses on the following primary functionalities:

- Authentication and Authorization using Auth0 with OIDC authorization code flow and Role-Based Access Control (RBAC) in middleware.
- CRUD operations on employee data which are restricted based on role.
- Employee Directory with search and efficient server-side pagination.
- Analytics Dashboard showing salary, department and employee statistics.
- Real-Time Notifications with read/unread filters.
- Team Management through organizational hierarchy.
- Self Profile Page for each employee that is editable only by HR users.

3.4 System Behavior Requirements

The system behaves according to the below defined rules:

- Authenticated users are redirected to the landing page with appropriate dashboards.
- First-time users are auto-synced into the MySQL database after login.
- HR role users have extended permissions (onboarding, salary updates, announcements).
- Notifications are pushed in real-time using a centralized system and visually marked as read/unread.
- Data displayed is tailored by the user identity (e.g., only HR can access all profiles, employees see only their own sensitive data).

3.5 System Performance and Non-Functional Requirements

- **Performance:** Implemented server-side pagination and lazy-loading search in order to reduce UI load time.
- **Scalability:** Built on Node.js + Express.js with modular design for future extensibility.
- **Security:** Auth0 integration ensures industry-standard authentication and JWT-based API access.
- **Maintainability:** The CI/CD pipeline ensures consistent and automated builds.
- **Availability:** Hosted using Docker and secure access using ngrok for TLS encryption.

3.6 System Context and Interface Requirements

- **Frontend Interface:** UI built using Angular, interacting with the backend through RESTful APIs.

- **Backend API:** Built on Node.js/Express.js, managing business logic, database operations, and Auth0 token validation.
- **Database Interface:** Initializes and uses MySQL to store employee data.

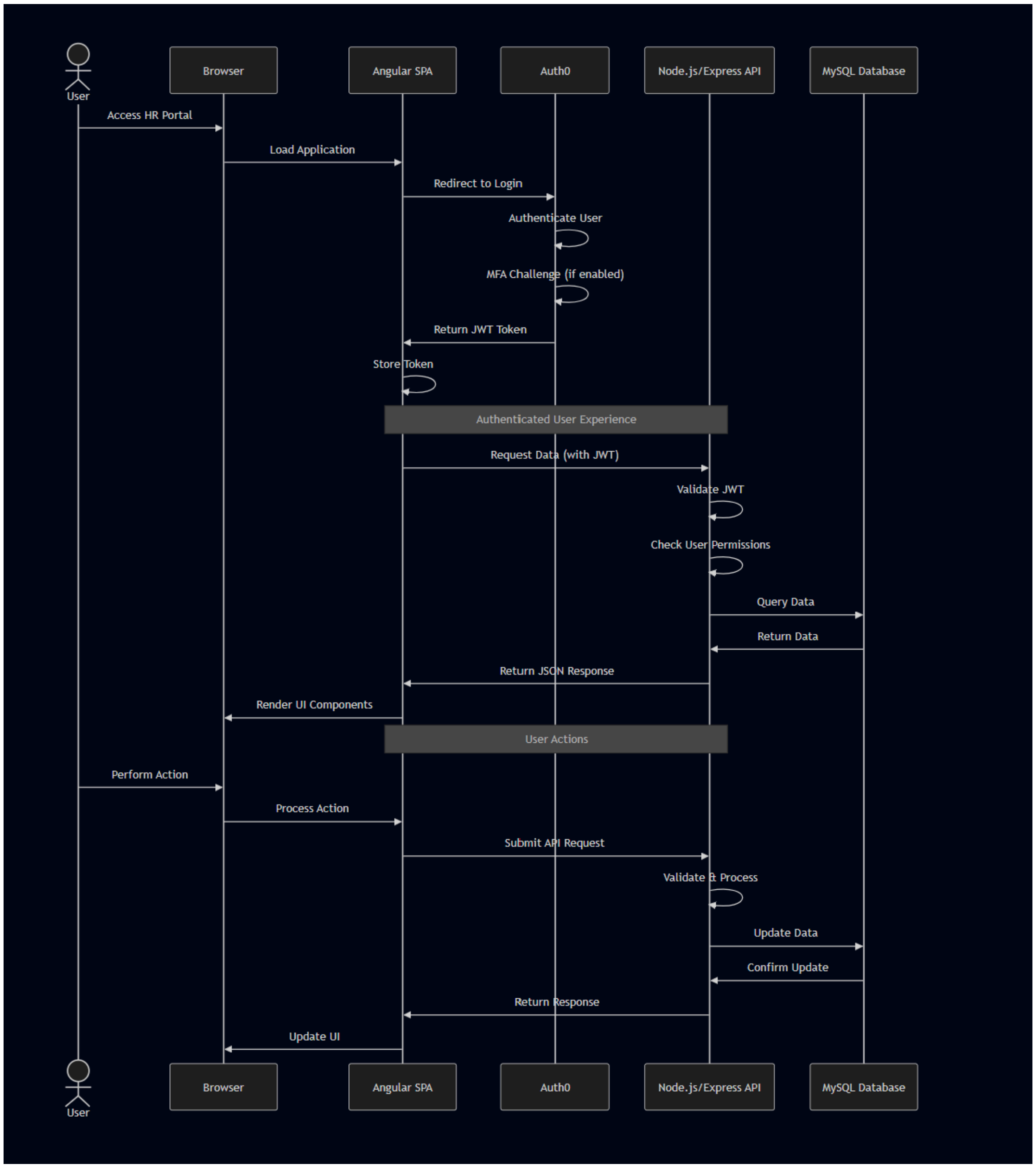
External Interfaces:
- Auth0 for authentication and RBAC.
- Jenkins for CI/CD pipeline management.
- Ngrok for exposing local services with secure tunnels.
- GitHub Webhooks for build triggers.

3.7 Technology and Resource Requirements
Technologies Used:
- **Frontend:** Angular
- **Backend:** Node.js, Express.js
- **Database:** MySQL
- **Authentication:** Auth0 with OIDC and RBAC
- **CI/CD:** Jenkins + Docker
- **Other Tools:** Ngrok, GitHub

Resource Requirements:
- A local development environment with Docker installed.
- Auth0 tenant details and client credentials data for integration.
- Jenkins server either locally or on a cloud machine.
- Developer access to GitHub for source control and CICD triggers.

Chapter 4 System Design

4.1 System architecture design
Enigma HR Solutions application uses a full-stack structured and modular architecture as mentioned below:
- **Frontend**: Angular SPA
- **Backend**: Node.js + Express.js
- **Authentication**: Auth0 via OIDC
- **Database**: MySQL
- **DevOps**: Jenkins + GitHub CI/CD, exposed via ngrok



4.2 **System data and database design**

The database design follows a relational model optimized for HR operations with indexing of columns, efficient normalization and relationships.

Key Entities

1. employees

   Core entity storing basic employee information

   Linked to departments and managers through constraints

Stores custom authentication identifiers for auto-sync with auth0

2. departments
   Organizational structure representation.
3. dept_emp
   Tracks which employee worked in what department and duration.
4. dept_manager
   Department managers and their active periods in the company in that department.
5. titles
   Tracks job designations held by employees over a period of time.
6. salaries
   History of salary changes over time for each employee.
7. notifications
   User-specific notifications and global notifications
   Supports different notification types
   Includes action data for interactive notifications

Database Schema:

```
CREATE TABLE `employees` (
  `emp_no` int NOT NULL AUTO_INCREMENT,
  `birth_date` date DEFAULT NULL,
  `first_name` varchar(14) NOT NULL,
  `last_name` varchar(16) NOT NULL,
  `gender` enum('M','F') NOT NULL,
  `hire_date` date NOT NULL,
  `auth0_id` varchar(100) DEFAULT NULL,
  PRIMARY KEY (`emp_no`),
  UNIQUE KEY `auth0_id` (`auth0_id`)
)
CREATE TABLE `departments` (
  `dept_no` char(4) NOT NULL,
  `dept_name` varchar(40) NOT NULL,
  PRIMARY KEY (`dept_no`),
  UNIQUE KEY `dept_name` (`dept_name`)
)
CREATE TABLE `dept_emp` (
  `emp_no` int NOT NULL,
  `dept_no` char(4) NOT NULL,
  `from_date` date NOT NULL,
  `to_date` date NOT NULL,
  PRIMARY KEY (`emp_no`,`dept_no`),
  KEY `dept_no` (`dept_no`),
  CONSTRAINT `dept_emp_ibfk_2` FOREIGN KEY (`dept_no`) REFERENCES
`departments` (`dept_no`) ON DELETE CASCADE
)
```

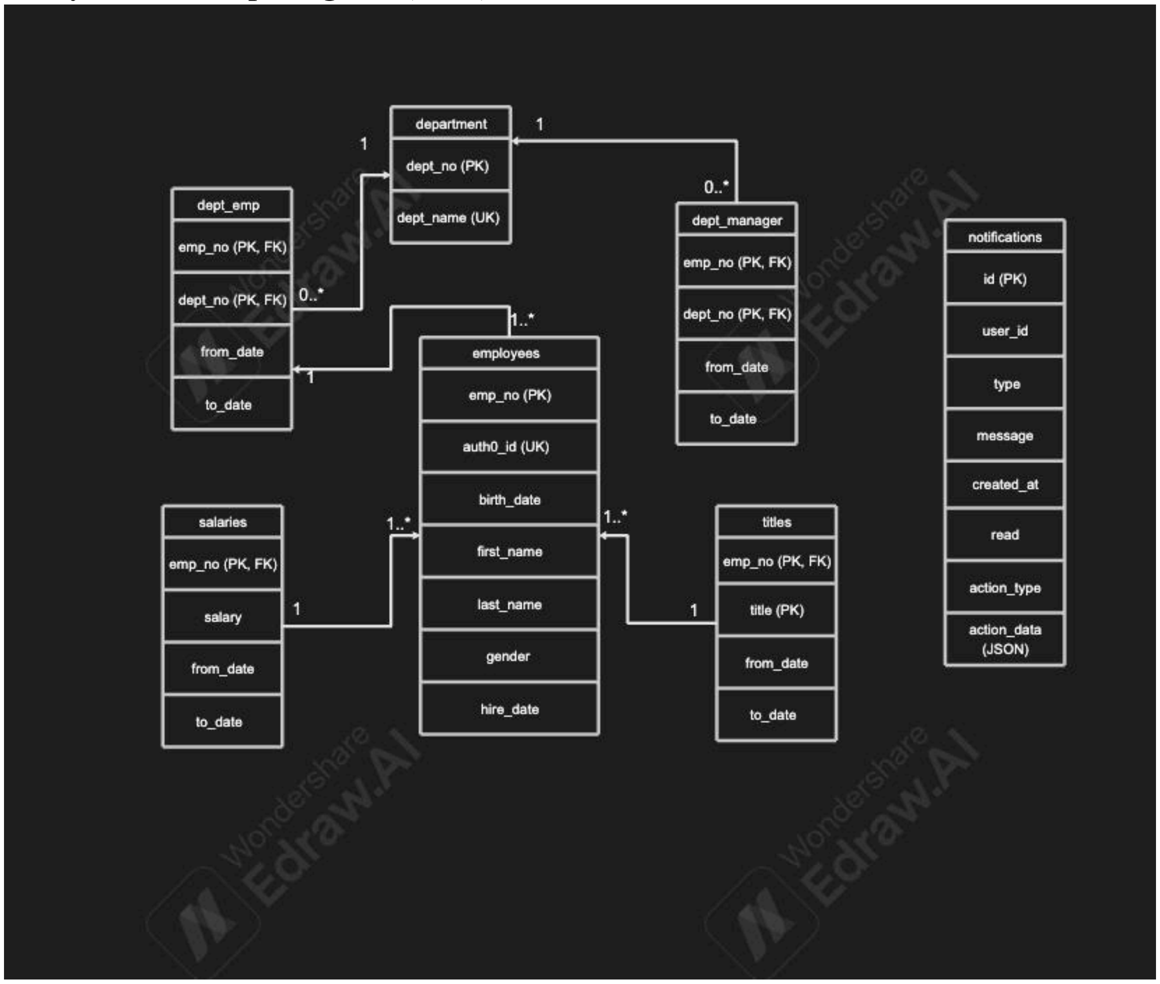
```
CREATE TABLE `dept_manager` (
  `emp_no` int NOT NULL,
  `dept_no` char(4) NOT NULL,
  `from_date` date NOT NULL,
  `to_date` date NOT NULL,
  PRIMARY KEY (`emp_no`,`dept_no`),
  KEY `dept_no` (`dept_no`),
  CONSTRAINT `dept_manager_ibfk_2` FOREIGN KEY (`dept_no`) REFERENCES
`departments` (`dept_no`) ON DELETE CASCADE
)
CREATE TABLE `notifications` (
  `id` int NOT NULL AUTO_INCREMENT,
  `user_id` varchar(255) NOT NULL,
  `type` varchar(50) NOT NULL,
  `message` text NOT NULL,
  `created_at` datetime DEFAULT CURRENT_TIMESTAMP,
  `read` tinyint(1) DEFAULT '0',
  `action_type` varchar(50) DEFAULT NULL,
  `action_data` json DEFAULT NULL,
  PRIMARY KEY (`id`)
)
CREATE TABLE `salaries` (
  `emp_no` int NOT NULL,
  `salary` int NOT NULL,
  `from_date` date NOT NULL,
  `to_date` date NOT NULL,
  PRIMARY KEY (`emp_no`,`from_date`)
)
CREATE TABLE `titles` (
  `emp_no` int NOT NULL,
  `title` varchar(50) NOT NULL,
  `from_date` date NOT NULL,
  `to_date` date DEFAULT NULL,
  PRIMARY KEY (`emp_no`,`title`,`from_date`)
)
```

Auth0 User Sync Logic:
When an AUTH0 user logs in:

- In middleware, we extract the unique sub (Auth0 ID) from the token.
- It queries the employees table using auth0id:
    - If the user found → returns employee record.
    - If not found → creates a new entry with the received name and auth0id.

This ensures every user authenticated via Auth0 is automatically mapped/synced or added to the database without manual onboarding.

Entity Relationship Diagram (ERD)



4.3 **System interface and connectivity design**

The system is designed with a clear separation of concerns, modular responsibilities, and secure communication ways between all the components.

Components & Flow

1. **User Interface (Angular Frontend)**

- Hosted as a Single Page Application (SPA).
- Redirects to the Auth0 login when a user accesses the application.
- Post-authentication, it receives an authorization code that can be exchanged for access token.

2. **Auth0 (OIDC Auth Code Flow)**

- Handles user login, multi-provider SSO, and token issuance.
- Returns an authorization code → frontend sends it to backend → backend exchanges it for access token.
- Ensures users are securely authenticated using standards-compliant OIDC.
- Makes login to Jenkins seamless using SSO.

3. **Node.js + Express Backend**

- Accepts requests from the Angular frontend with JWT in headers.
- Verifies and validates the token with Auth0 public keys.
- On first login, look up the auth0id in the employees table to sync user details with the database.
- Serves authorized data (CRUD, stats, notifications) to the frontend based on role check in middleware.

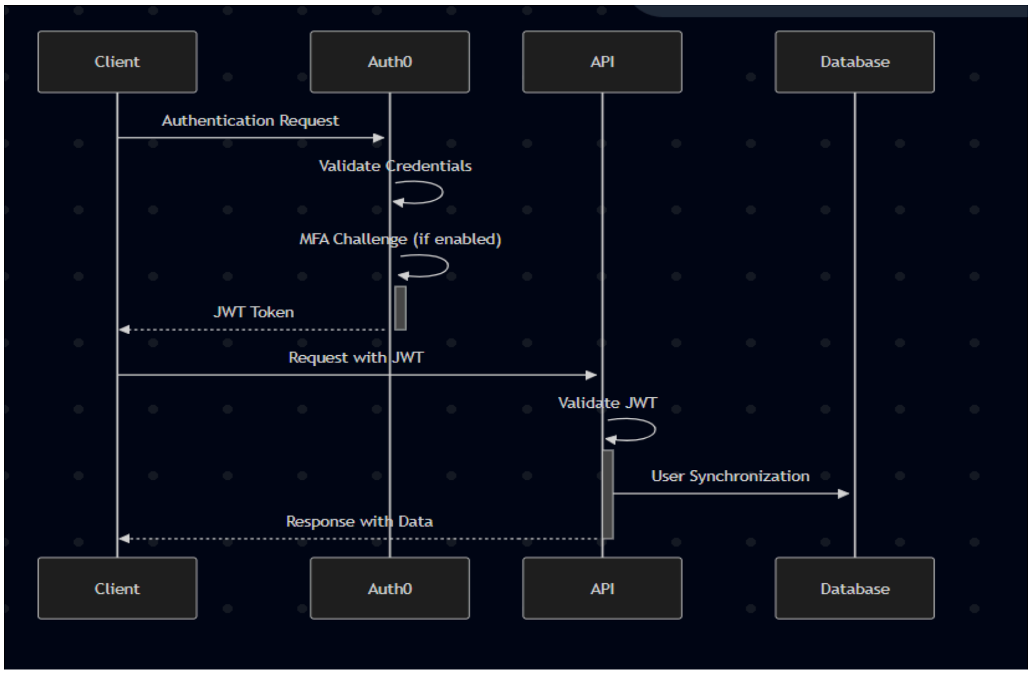
4. **MySQL Database**

- Stores persistent employee and HR-related data.
- Indexed columns to improve performance.
- The backend performs all read and write operations using secure parameterized queries.

Connectivity Protocols

1. Authentication Flow

- All sensitive API endpoints are protected using middleware role check.
- Role-Based Access Control (RBAC) is applied after token verification using Auth0 roles extracted.
- JWT tokens are passed securely via HTTPS.



4.4 System user interface design

The frontend of Enigma HR Solutions is built using Angular and follows a modular component-based structure that enforces responsiveness and smooth navigation.

General Design Philosophy

- **SPA** (Single Page Application) behavior using Angular routing methodology.
- **Secure UI**: Visibility and actions depend on the user's Auth0 role (e.g., HR, Manager, Employee).
- **Real-Time Interactions**: Notification center and dashboard widgets update dynamically in real-time.

Key UI Components

1. **Login & Auth Redirect**
   Component: AuthComponent, CallbackHandlerComponent
   Features:
   - Redirects to Auth0 login.
   - Handles OIDC callback.
   - Stores token and user profile in frontend state.
2. **Dashboard**
   Component: DashboardComponent
   Role-Specific Views:
   - HR: View total employee count, Department-wise statistics, Salary averages and trends
   - Employee: See basic organizational insights, Real-time notifications
3. **Employee Directory**
   Component: EmployeeListComponent, EmployeeCardComponent
   Features:
   - Displays employee info as cards or in a table
   - Includes filters for department, title, and name
   - Implements server-side pagination and lazy search

   Access:
   - HR: Full access with edit options
   - Employees: Limited view (names and roles only)
4. **Notifications Center**
   Component: NotificationComponent
   Highlights:
   - Realtime updates for tasks, announcements
   - Read/unread tracking
   - Toast alerts for high-priority update

5. My Profile Page
Component: MyProfileComponent
Details:
- Displays personal and professional details
- Allows editing by HR only

Access:
- Employees: read-only
- HR: editable form fields

6. My Team View
Component: MyTeamComponent

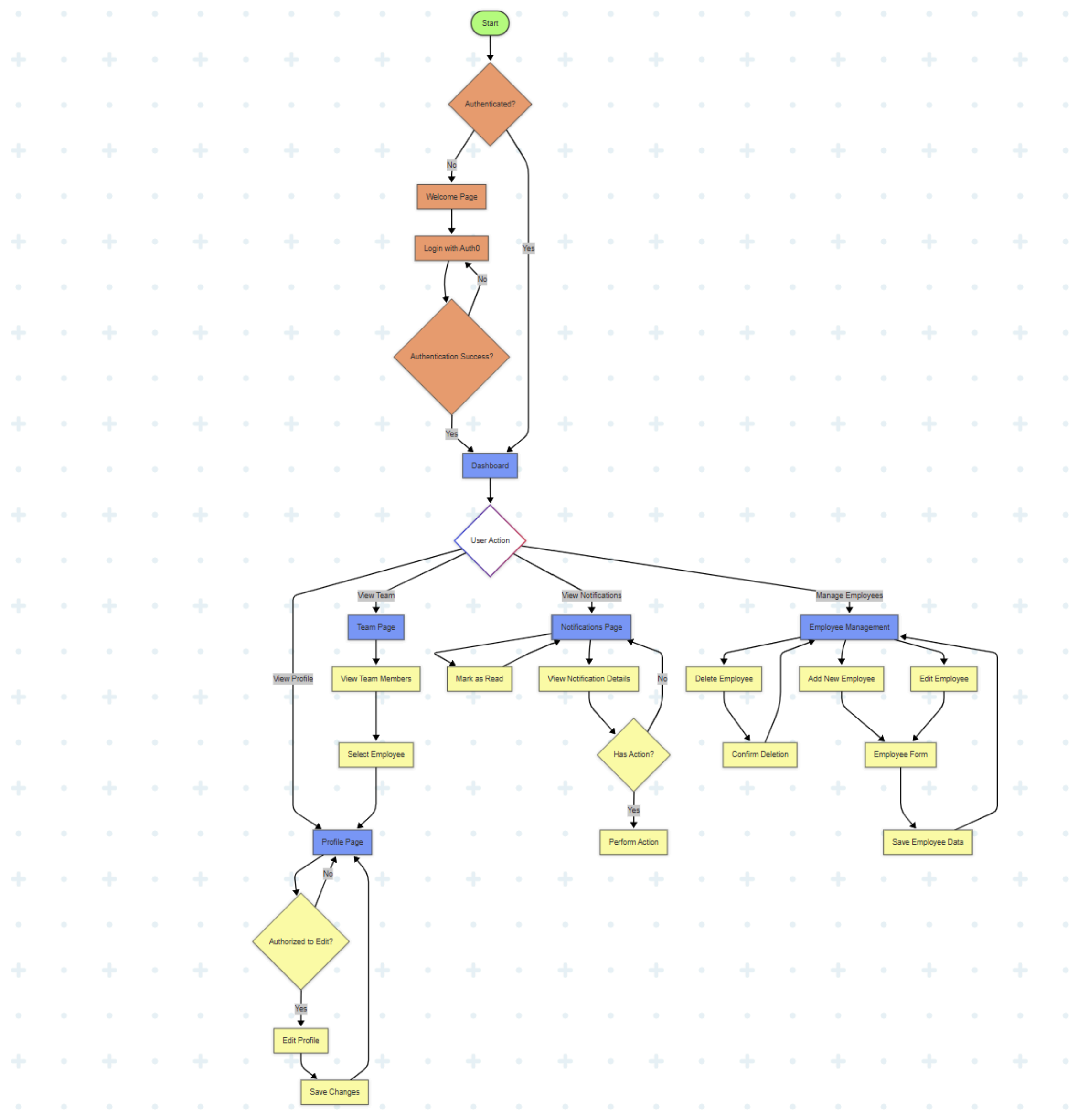
Purpose: Allows any employee to view their team structure based on department
Features:

- Displays a list/grid of coworkers in the same department
- Shows: Name, Title, Contact email

Operation Flow

1. **Authentication Flow**
   Auth0 login → Welcome page with Dashboards
   SSO options with corporate identity providers
   MFA challenge when required
2. **Employee Management Flow**
   Dashboard → Team view → Employee profile → Edit profile
   Role-based access controls on operations
3. **Notification Flow**
   System events → Notification generation → User notification
   Interactive notification responses

User Flow Diagram:



4.5 System component API and logic design

Enigma HR follows a modular RESTful architecture for its backend, built using Node.js and Express.js. The backend serves as the API layer between the Angular frontend and the MySQL database, while enforcing robust security, authentication, and role-based permissions.

Key Design Principles

- **Separation of Concerns**: Routes, controllers, middleware, and config are separated by responsibility.

- **Scalability**: Each feature is modular, allowing independent development and extension.
- **Security**: All APIs are protected using Auth0 JWTs and fine-grained role checks.
- **RESTful APIs**: CRUD operations follow REST conventions using HTTP verbs (GET, POST, PUT, DELETE).

Backend API Components

1. **employeeController.js**
    - Handles creating, updating, and fetching employee records
2. **statisticsController.js**
    - Manages the analytics of employee and department data
3. **profileController.js**
    - Returns employee information
    - Can be used for updating employee data
4. **notificationController.js**
    - Sends and retrieves real-time notifications
    - Tracks read/unread status of them
5. **teamController.js**
    - Handles retrieval of team records

Routes

Routes are defined in the routes folder and are responsible for mapping HTTP endpoints to the appropriate controller functions. They also integrate middleware to enforce authentication and RBAC.
Route Files:

1. **employeeRoutes.js**
    a. /api/employees
    b. Includes routes like:
        i. GET / – List all employees
        ii. GET /:id – View specific employee data
        iii. POST / – Create employee
        iv. PUT /:id – Update or edit employee
2. **profileRoutes.js**
    a. /api/profile
    b. Used for populating specific employee info
3. **notificationRoutes.js**
    a. /api/notifications
    b. Used for retrieving and marking notifications as read
4. **statisticsRoutes.js**
    a. /api/stats
    b. To get analytics of employee
5. **teamRoutes.js**
    a. /api/team

b. To get team of an employee

Middleware

Middleware functions are used to:

- Authenticate requests via JWT tokens
- Validate user roles
- Log proper and meaningful errors

Middleware Files:

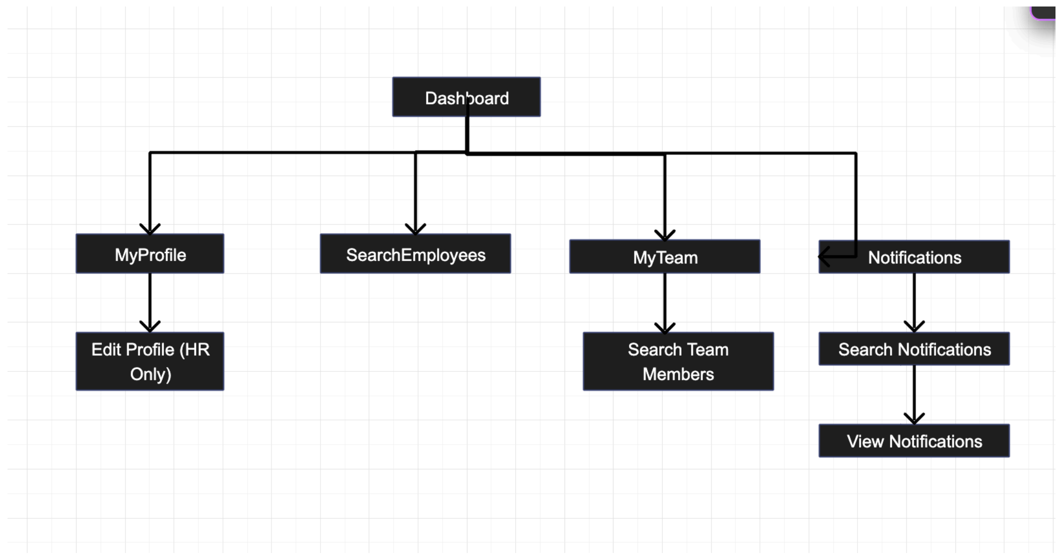
1. **checkJwt:**
   a. Verifies the JWT passed in the request headers using Auth0's public key
   b. Attaches the decoded user profile to req.user
2. **checkRole:**
   a. Verifies that the authenticated user has the required role to access the API
   b. Returns 403 Forbidden error if the role check fails
3. **errorHandler:**
   a. Catches unhandled exceptions and returns back uniform error responses

Config & Environment Handling

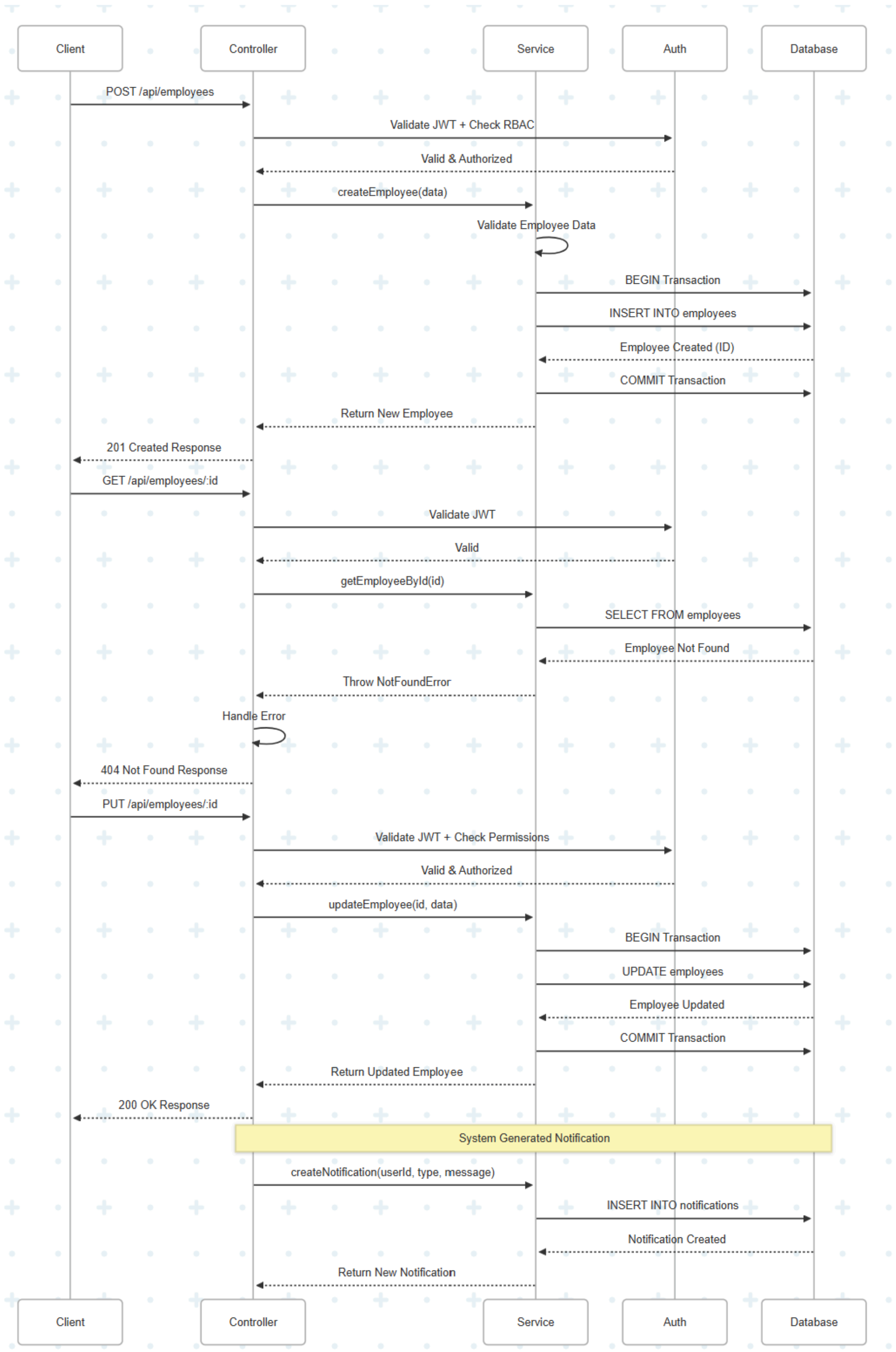
The application uses a .env file and a centralized config directory to manage:

- Auth0 client credentials and application domain
- Database connection settings
- Port numbers and environment info

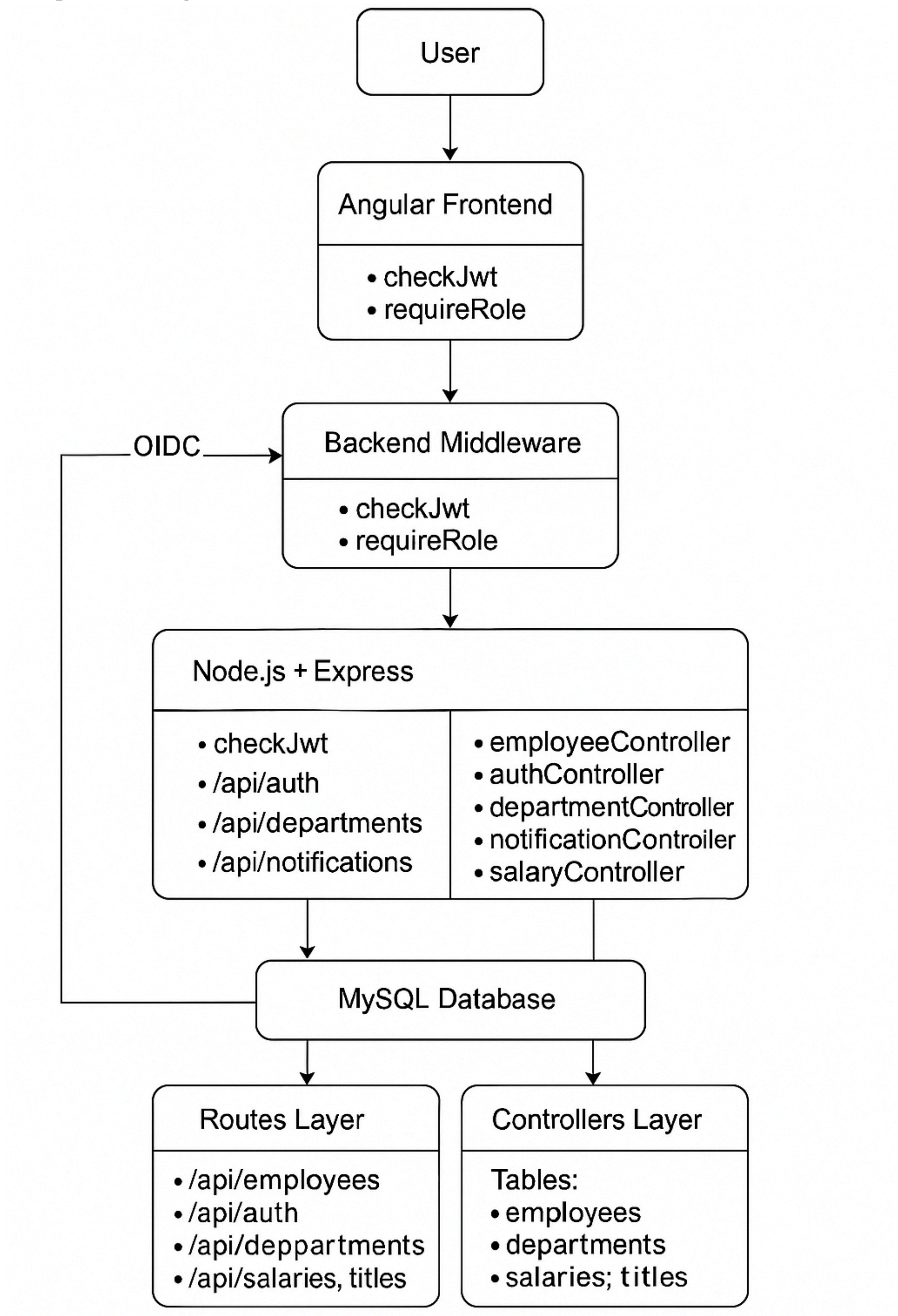
UI Structure Diagram



API Logic Flow Diagram:



Component Diagram



4.6 Design problems, solutions, and patterns

Problem 1: Authentication and Authorization
Challenge: Implementing secure authentication with SSO while maintaining proper role-based access control and user onboarding.
Solution: Integration with Auth0 as an identity provider with custom middleware for role synchronization.

- JWT-based token validation
- Role claims embedded in tokens
- User synchronization between Auth0 and the MySQLdatabase
- Permission-based access control on API endpoints

Problem 2: Real-time Notifications
Challenge: Providing users with timely notifications about important events.
Solution: Hybrid approach combining polling and WebSocket technology.

- Database-persisted notifications for reliability
- Structured notification schema with action metadata
- Notification center UI component
- Read/unread state management using efficient table relationships design

Problem 3: Security and Data Protection
Challenge: Ensuring data security and compliance with privacy regulations.
Solution: Multi-layered security approach.

- HTTPS used for all communications between components
- Prepared statements to prevent SQL injection
- Input validation and sanitization before processing it.
- Data access logging
- Role-based data visibility for access control

Problem 4: Frontend State Management
Challenge: Managing complex application state across components.
Solution: Service-based state management with reactive programming.

- Angular services for shared state programming
- RxJS observables for reactive updation of data
- Component isolation with structured data flow
- Lazy loading for performance optimization

Chapter 5 System Implementation

5.1. System implementation summary

Enigma HR Solutions is a **full-stack, three-tiered web application**:

- **Frontend** – an Angular single-page application that manages state, user interface, and Auth0's SPA SDK for the OIDC code-flow login redirect.
- **Backend** – Employee management, analytics, and notification endpoints are exposed by the backend, which is a Node.js + Express REST API that receives the Auth0 authorization code, converts it to a JWT, and verifies the token on each request.
- **Data layer** – Employee records, roles, and notification metadata are stored in the data layer, a MySQL database that is automatically provisioned or initialized when the server boots up.

Key runtime flows include:

1. **SSO & RBAC** – Fine-grained access is enforced on all API routes through SSO & RBAC. Users authenticate using Auth0, and the backend confirms the JWT and adds the role (HR, manager, or employee) to the request context.
2. **Employee management** – While other roles have read-only or scoped access, HR can add or edit records using CRUD endpoints..
3. **Dashboards & analytics** – The Angular dashboard displays real-time headcount, salary, and turnover charts that are powered by aggregated queries.
4. **Notifications** – Users never miss HR announcements or onboarding tasks thanks to real-time, in-app alerts that are sent to a single notification center.

Through each GitHub push, the Node and Angular projects are automatically built by a **Jenkins CI/CD pipeline** (which runs in Docker and is accessible via ngrok), providing quick feedback and repeatable deployments. **Auth0 OIDC** front-stops Jenkins, which runs in Docker and inherits the same HR/Manager/Employee roles as the main application. Auth0 also makes Google and GitHub connections available for one-click login.

5.2. System implementation issues and resolutions

Issue encountered	**Resolution implemented**
Role checks were broken because Auth0 users were able to log in but were not listed in the employees table.	HR can now add department, salary, and other details to the profile by using the first-login sync hook, which automatically inserts a skeleton record when it detects unknown Auth0 user IDs.
Large employee datasets caused long browser paint times.	Reduced payload size and render time by introducing server-side pagination and lazy-loaded search, which allow the user interface to retrieve only the current page and on-demand matches.
OAuth callback mismatch during Jenkins SSO	Added correct redirect URI in Auth0 & Jenkins OIDC settings

Google/GitHub login not provisioning roles	Implemented Auth0 Rule to map social-provider users to default project roles
Manual builds slowed iteration.	To accomplish unattended, push-triggered builds, Jenkins was Dockerized, a GitHub → Jenkins webhook was wired, and the local server was published using ngrok.

5.3. Used technologies and tools

- Backend – Node.js, Express
- Database – MySQL
- Frontend – Angular
- Auth & security – Auth0 SSO, OIDC code flow, JWT validation
- Role-based access – custom RBAC middleware
- CI/CD – Jenkins (Docker), GitHub webhooks
- TLS tunnelling / external demo – ngrok
- Dashboard & analytics – Angular charts fed by MySQL views
  Jenkins + OIDC plugin, Auth0 tenant with **Google/GitHub connections**, Docker, ngrok tunnel, GitHub webhooks

Chapter 6 System Testing and Experiment

6.1 Testing and experiment scope

Testing covered all critical user journeys:

- Authentication & SSO round-trip (login, logout, token refresh)
- Role-restricted CRUD (HR vs manager/employee) on employee records
- Dashboard metric accuracy (head-count, salary trends)
- Real-time notifications delivery & read/unread state
- Performance under dataset growth (pagination, search)
- **Scope** – Added scenarios for Jenkins SSO login/logout, RBAC enforcement, and Google/GitHub social authentication.

6.2 Testing and experiment approaches

Layer	**Approach**	**Tooling/pipeline integration**
Backend API	**Automated unit & integration tests** for controllers, services, and Auth0 token guards	Run via npm test inside the Jenkins pipeline
Frontend	**Cypress end-to-end scripts** simulating HR and employee sessions	executed in headless Chrome during CI
Performance	Data-set scaling scripts + browser Lighthouse runs to measure first-contentful paint before/after pagination optimisation	manual and CI-triggered
Security	Auth0 rules + JWT tampering checks; attempted unauthorised API calls in automated tests	part ofthe integration suite

6.3 Testing and experiment

- SSO flow – 100 % pass; average redirect-to-dashboard time ≈ 1.2 s end-to-end.
- RBAC – all 24 positive/negative permission scenarios passed; unauthorised mutation attempts correctly returned *403 Forbidden*.
- Data operations – CRUD latency remained < 150 ms for 10k-row employee tables thanks to pagination and query indexing.
- Dashboard metrics – cross-checked against raw DB queries; no discrepancies found.
- CI/CD – median pipeline time 2 m 40 s; success rate 100 % over last 30 pushes.
- User-perceived performance – Lighthouse performance score improved from 61 → 88 after server-side pagination
- 100 % pass: Jenkins accepted only Auth0-issued tokens; social logins completed in < 2 s median and respected role restrictions.

Chapter 7 : Conclusion and Future Work

7.1 Project summary

A safe, role-aware HR portal that simplifies employee onboarding, record-keeping, analytics, and communication throughout the company is successfully delivered by the project. Enterprise-grade authentication is ensured by Auth0 SSO, and continuous integration is offered by a Jenkins pipeline built on Docker. Even as data volume increases, responsiveness is guaranteed by performance optimizations. Jenkins' integration with social logins and Auth0 SSO improved security and streamlined developer onboarding without increasing maintenance costs.

Project Status

The project has reached a significant milestone with the successful implementation of all core requirements:

1. **Authentication and Security**
   - Single Sign-On (SSO) integration with Auth0
   - Role-Based Access Control (RBAC)
2. **HR Functionality**
   - Employee management and profiling
   - Team organization and hierarchy
   - Notification system
   - HR analytics and statistics
3. **Technical Infrastructure**
   - Angular frontend (v19.2.0)
   - Node.js/Express.js backend
   - MySQL database with Sequelize ORM
   - CI/CD pipeline with Jenkins

7.2 Future work

Even though the Enigma HR Solutions portal has effectively fulfilled all essential requirements, there are still a number of opportunities for improvement and growth in the future:

- **Automated user provisioning—**In order to preserve a single source of truth, automated user provisioning pushes HR-added employees back to Auth0 via the Management API.
- **Mobile-first UI** – introduce a responsive PWA or native mobile clients for on-the-go HR tasks.
- **Advanced analytics** – use machine learning models to benchmark compensation and predict attrition.
- **Audit & compliance** – for SOX/ISO 27001 readiness, include role delegation workflows and unchangeable audit logs.ess.

- Add step-up MFA for high-risk Jenkins jobs, extend social providers (like Microsoft AAD), and export SSO audit logs to a SIEM for in-the-moment monitoring.
- **Scalable hosting—**for high availability, switch from a local Docker/ngrok stack to a managed Kubernetes or serverless environment.

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