Universe Academic Automation System

Capstone Project | University of Benghazi | 2023–2025

Abstract

Universe System is a microservices-based academic automation platform designed to solve the problem of fragmentation in academic workflows across Libyan universities. Built over two years and deployed for real use at the University of Benghazi, it automates GPA calculation, scheduling, user management, course enrollment, announcements, research uploads, and more.

With an emphasis on national data sovereignty, offline capability, and modularity, Universe is aligned with the National Education Strategy 2030. It includes over 12 microservices, each running independently and communicating via RabbitMQ or REST APIs.

Motivation & National Relevance

- Replace fragmented tools like WhatsApp, Excel, and external LMS platforms
- Support local hosting (air-gapped if needed)
- Empower national software development
- Design for scalability and offline operation
- Enable data compliance with Libyan educational policies

System Architecture (C4 Modeled)

High-Level Components: - **API Gateway:** Central entry, JWT validation, request routing - **Eureka Discovery:** Register/locate microservices - **RabbitMQ:** Handles all async communication between services - **PostgreSQL:** Database for relational persistence - **Redis:** Token blacklist, session management - **React Frontend:** Clean and accessible dashboard per role

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Complete List of Services

1. Auth Service

- JWT + Refresh tokens
- Login, signup, password recovery
- RBAC enforcement + route access control
- Token revocation using Redis

2. User Profile Service

- Stores name, avatar, contact info, language
- Notification preferences
- Profile access by role

3. Course Service

- Creates, updates, and deletes courses
- Handles course info, descriptions, credits
- Maps lecture halls to GPS coordinates

4. Grades Service

- GPA engine with weight rules
- Grade reporting and statistics
- Supports dynamic course-specific grading policies

5. Enrollment Service

- Register/unregister students in courses
- Checks prerequisites and max limits
- Handles waitlists and admin override

6. Time Schedule Service

- Defines academic calendars
- Prevents lecture overlaps
- Auto-assigns lecture slots and days

7. Event News Service

- Shows public announcements and deadlines
- Integrates with calendar widget
- Powers public-facing event site

8. Department Service

- Stores department symbols and faculty relations
- Links courses to departments with rules
- Enables department-level analytics

9. College Service

- Adds, updates, deletes college entries
- Provides high-level control for admins
- Central dashboard for global statistics

10. Notification Service

- Consumes RabbitMQ messages
- Sends emails and SMS via external gateway
- Optional push notification module planned

11. Research Service

- Uploads student research (PDF + metadata)
- Stores encrypted research locally
- Access controlled per user role

12. Material Service

- Teachers upload learning content
- Offline caching for students
- View/download tracking

13. Compiler Service

- Runs code securely using Docker sandboxes
- Returns output/errors
- Designed for programming education

14. External Portal

- Public-facing portal
- Shows degrees, news, announcements, events
- Customizable college branding

Advanced Features

- **Offline-First LMS**: Cached materials, quizzes, and even video lectures
- **Academic Dashboard**: Admins monitor student progress and system-wide KPIs
- **Automated GPA Engine**: Fully rules-based, tracks semester GPA & CGPA
- **Advisor Tools**: See advisee load, GPA, warnings, enrollments
- **Role-Specific Views**: Different UI and features per role (student, teacher, admin)

Security Model

- JWT + RSA-256 token encryption
- Redis token blacklist for logout control
- RBAC for permission enforcement
- CORS and CSRF protection via Spring Security
- Rate limiting on API Gateway

Testing & Stability

- 80%+ test coverage using JUnit and Mockito
- Testcontainers for integration testing with PostgreSQL + RabbitMQ
- Simulated load test for 2000 concurrent users
- Zero downtime deployment with Docker Compose + versioning

Deployment & Real Usage

- Used by faculty and students at the University of Benghazi
- Designed to be deployed offline in rural or remote areas
- Accessible via web and optional desktop client
- All data is stored locally to support sovereignty

Roadmap

- MFA login support via OTP/email link
- New exam proctoring microservice
- Integration with HR and student record systems
- Mobile app version (planned for Flutter)
- Monitoring and logging via Prometheus + Grafana

Technology Stack

- **Backend**: Java 21, Spring Boot, Spring Security
- **Frontend**: React, TailwindCSS
- **Messaging**: RabbitMQ (AMQP)
- **Storage**: PostgreSQL, Redis
- **Deployment**: Docker, Docker Compose
- **CI/CD**: GitLab, GitHub Actions

Vision

Universe is not just a final year project. It is a proof of what a focused, national-first software effort can look like. It empowers universities in Libya to take control of their academic data and improve learning without reliance on foreign tech.

With continued development and funding, it could scale to every university in the region.

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