Faculty of Engineering of the University of Porto

Homework 05

Library System Architecture

M.EIC010 - Software Systems Architecture

1MEIC03 - T32

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Introduction

The automated library system represents a comprehensive solution designed to modernize and streamline library operations in today's digital age. At its core, the system is built to efficiently manage the library's vast collection of media while providing seamless access to patrons through various channels. By integrating robust modules for user authentication, catalog management, checkout and reservation, inventory control, notification systems, and collaboration with other libraries, this architecture aims to enhance the overall library experience for both patrons and staff.

High-Level Architecture Design

The system’s high-level architecture is split into 8 major modules, with connections between one another. Each major module contains minor modules to showcase its functionalities.

UI Module

This module is accessible via various devices, such as personal ones (mobile phone or computer) or dedicated library stations, and is responsible for enabling the interaction between the patrons, the staff, and the system, where all of its functionalities can be accessed. This module also allows anonymous users to interact with the system through the use of computers in the library.

Authentication System Module

This abstraction is responsible for handling and managing patron accounts, including their access permissions. In this way, it is also responsible for the relation between patron cards and their virtual accounts, either on a personal device or via card on a library station. This module interferes with several others like the Catalog Management Module, as, while a search is available for everyone, only staff are allowed to use management functionalities like adding, removing, updating, and categorizing items in the catalog.

Catalog Management Module

This module manages the library's collection, including physical and electronic media. It provides search functionalities based on several criteria, such as author, title, genre, and language, and management functionalities like adding, removing, and updating item

categories.

Inventory Management Module

Enables the management of the libraries' physical inventories by handling the addition, removal, and tracking of items. In other words, it supports inventory updates, stocktaking, and maintenance operations.

Checkout and Reservation Module

This part facilitates the checkout process for patrons, including reserving books that are currently checked out. Plus, it also allows patrons to consult and manage their borrowing history, as well as staff to update the status of a given reservation

Notification Module

To send notifications to patrons via email, SMS, or the mobile app, this module needs to communicate with others, such as the Checkout and Reservation Module, to inform patrons about overdue books, upcoming due dates, and general updates to reservations. Additionally, it needs to exchange knowledge with the Fine Management Module to adequately warn patrons of their debts.

Collaboration Module

Plays a crucial role in expanding the library's resource pool, enabling patrons to access a wider range of materials, as it facilitates collaboration and resource and knowledge sharing. In this way, it will further enhance the automated system by providing an interlibrary loan system, which enables the lending and shipping of materials between different libraries. Furthermore, it will offer a centralized catalog integration, as searches are conducted to a centralized database for patrons to quickly identify their desired book.

Inter-library Loan System:

- Facilitates the borrowing and lending of materials between different libraries.
- Allows patrons to request items from partner libraries if they are not available in their own library's collection.
- Manages the process of requesting, shipping, and returning borrowed items.

Resource Sharing Protocol:

- Defines protocols and standards for exchanging information and resources with

partner libraries.

- Establishes communication channels and data formats to ensure compatibility and interoperability between systems.

Centralized Catalog Integration:

- Integrates the catalogs of partner libraries into a centralized database for unified search and access.
- Allows patrons to search for items across multiple libraries and request them seamlessly.

Interlibrary Communication Channels:

- Provides communication channels for staff members to interact with counterparts in partner libraries.
- Facilitates coordination for resource sharing, resolving disputes, and exchanging best practices.

Data Privacy and Security Measures:

- Implements measures to ensure the privacy and security of patron data shared between libraries.
- Adheres to data protection regulations and standards to safeguard sensitive information during interlibrary transactions.

Fine management Module

Enables efficient management of fines by tracking and calculating them. It also processes online and in-person payments. Finally, ensures report generation on the collected fines for administrative purposes. All of this requires communication with the Checkout and Reservation Module.

- **Fines Calculation**: This module calculates fines based on predefined rules set by the library, such as daily or hourly rates for overdue items.
- **Fine Tracking**: It tracks the fine amounts accrued by patrons for each overdue item and maintains a record of payment status.
- **Payment Processing**: Facilitates payment processing for fines through various payment methods, including online payment gateways, in-person payments, or integration with existing library systems.
- **Reporting**: Generates reports on fines collected, outstanding fines, and trends in fine payments for administrative purposes.
- **Integration**: Integrates with the checkout and reservation module to apply fines

automatically when items are returned late.

Architecture Implementation Design

Frontend

The user-facing aspect of the application is divided into two primary platforms: mobile and computer. Mobile users can access the system through either the Android or iOS app or via the web application. Meanwhile, computer users can utilize the desktop and the web application.

All these platforms interact with the backend through API entry points and endpoints, connecting to the backend hosted on the Library's servers.

Backend

Similar to the frontend, communication with the backend occurs through the API middleware, which verifies tasks and utilizes a load balancer to assign them to specific servers within the library cluster. Each server has an associated database to store data in. For the collaboration module to function, the library server clusters communicate with a centralized cluster containing information from multiple libraries. This cluster synchronizes data on media, checkouts, fines, etc., facilitating seamless back-and-forth communication.

Design Documentation

The diagram in Fig.1 outlines the architecture mentioned in the first section. This documentation provides a comprehensive overview of the system's components, their interactions, and the rationale behind design decisions, aiming to guide implementation and ensure the system meets the diverse needs of libraries and their users.

Each module mentioned above is represented in the diagram by a labeled box. Inside each box, some features of the system are enabled by the module it is included in. Each box can have one or more colors out of four. By employing this color scheme, the diagram visually distinguishes between system functionalities by user roles, facilitating a clearer understanding of the system's capabilities. The following colors are present:

- **Green:** Features accessible and performed by staff members of the library within the system**.**
- **Blue:** Features for patrons, either performed by them or accessed by them.

- **Orange:** Features available to anonymous users, such as searching media in the catalog using library computers.
- **Purple:** Features provided inherently by the system, such as automatic calculation and notification of fines for overdue media.

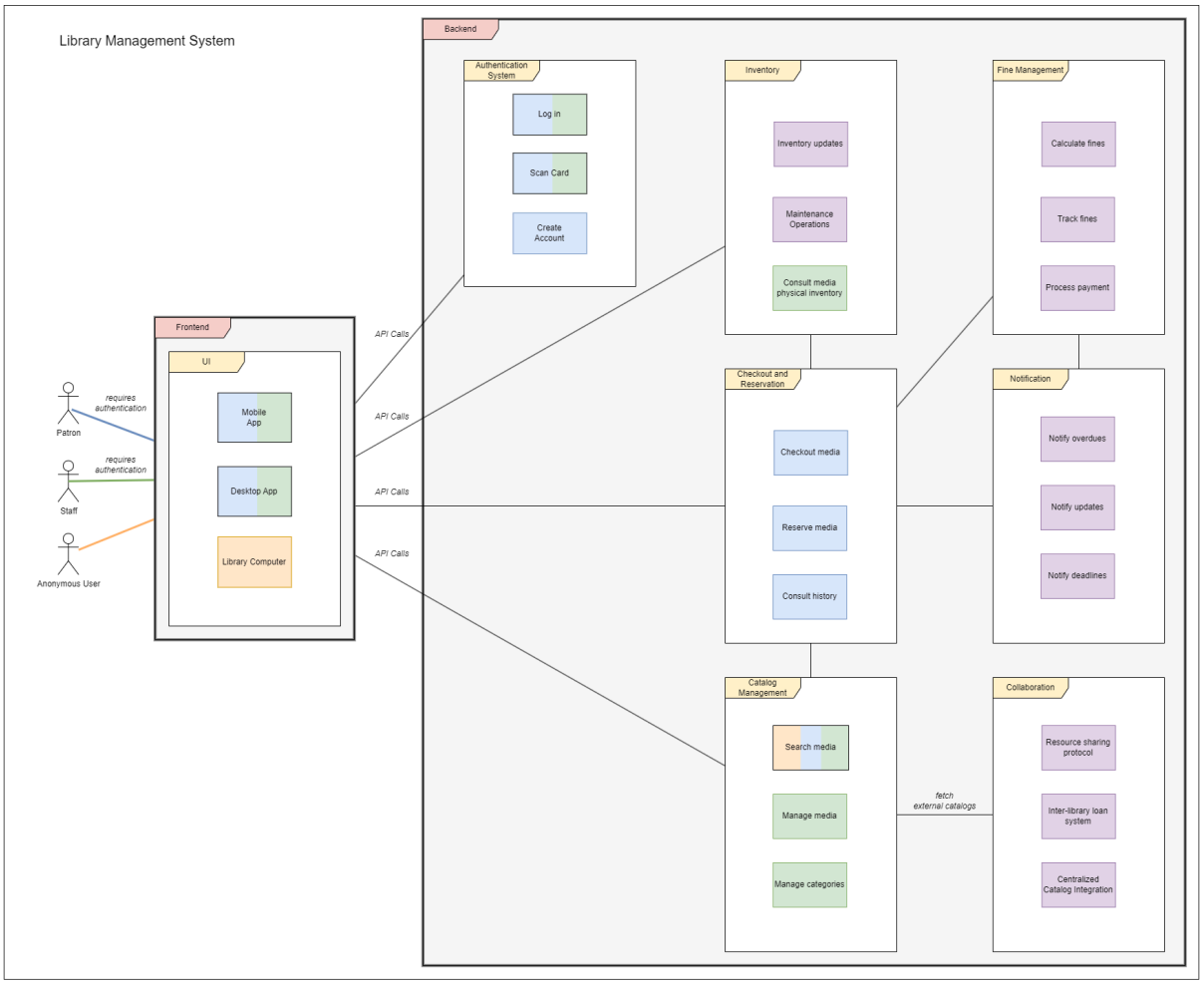
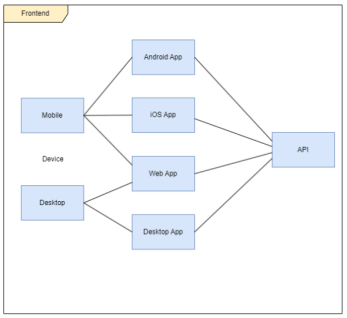


Fig 1. Library Management High-Level System Architecture

The diagrams in Fig. 2 contain the implementation of the system's architecture referred to.



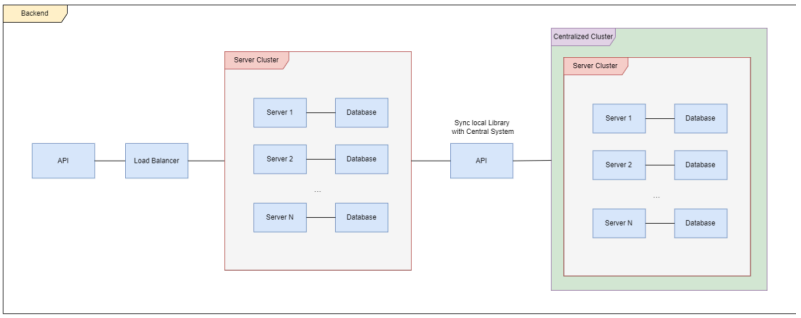


Fig 2. Library Management Architecture Implementation

Scenarios

Scenario 1: Patron searches for a book and checks it out

This scenario begins with a patron login into the system, using the Authorization Module through the interaction with the UI module. Next, the patron uses the search tools, provided by the UI, to search media, which is a feature supported by the Catalog Module. Finally, through the use of the Checkout and Reservation Module, the user checks out a book or any other type of media. This scenario uses the UI Module heavily since the user needs the UI to perform all the tasks to reserve the book.

Scenario 2: Patron receives a notification about an overdue return

Like the previous scenario, the patron needs to log in to be able to access the features provided by the desktop and mobile applications. Once the user is in the app, they will be able to see any automatic notifications sent by the system. In this case, the system will see the user hasn't yet returned the media and will send a notification, via the Notification Module, to inform the user of the late return and its consequences. Later, the moment the user returns the media, the system will also automatically calculate the fine, using the Fine Management Module, and the patron has to pay it to finish the return.

Conclusion

In conclusion, our design architecture for a library management system addresses the diverse needs of patrons and staff members of modern libraries by breaking down their system into eight modules with specific functionalities and systems.

The UI module serves as a gateway for users to interact with the system, whether they are using a mobile phone or a desktop. The Authentication module ensures secure access to patron accounts, while the Catalog Management module facilitates easy searching and management of the library's collection of media. Moreover, features such as Inventory management, Checkout and Reservation, Interlibrary Collaboration, Notification and Fine

Management modules contribute to a better overall experience when using the application, for example, by facilitating the staff's tasks by providing automatic notifications.

Overall, this architecture promotes efficiency, good coupling, and collaboration, laying a proper foundation for the evolving needs of a modern library system.