**Software** **Architecture** **(2025)**

**Case Description**

The Library Management System comprises eight business services, namely: Borrow Book, Return Book, Calculate Overdue Fines, Renew Book, Reserve Book, Search Book, Pay Fine, and Manage Reader Account. The development details of each service are described as follows:

**1) Service Name: Borrow Book**  
**Service Description:** As a reader, I want to borrow books so that I can read them.  
**Triggering Event:** The reader clicks the "Borrow" button in the system interface.  
**Basic Flow:**

1. Validate the reader's account (i.e., ensure it is registered, not frozen, and has no outstanding fines);
2. Check if the book is available for borrowing (i.e., status is "available" and not reserved);
3. Record borrowing information (reader ID, book ID, borrowing date, due date);
4. Update the book status to "borrowed";
5. Notify the reader of successful borrowing.  
   **Alternative Flows:**  
   1a. If the account is invalid or frozen, prompt: "Account unavailable, please contact the administrator";  
   2a. If the book is unavailable, prompt: "Book not available due to being borrowed or reserved";  
   3a. If the borrowing record fails to save, prompt: "System error, please try again."  
   **Acceptance Criteria:**

* Reader account is valid and has no unpaid fines;
* Book status must be "available" and not reserved;
* Borrowing record includes both the borrow date and due date (default loan period: 30 days);
* After status update, other users cannot borrow or reserve the book;
* Reader receives a confirmation notification via SMS or email.

**2) Service Name: Return Book**  
**Service Description:** As a reader, I want to return books so that they become available to others.  
**Triggering Event:** The reader scans the book's barcode at a self-service return station or clicks the "Return" button in the system.  
**Basic Flow:**

1. Verify that the book belongs to the current reader;
2. Check for overdue status—if overdue, trigger the "Calculate Overdue Fines" service;
3. Update the book status to "available";
4. Update the borrowing record to "returned";
5. Create a return record;
6. Notify the reader of successful return. If the book is reserved, notify the highest-priority reserving reader.  
   **Alternative Flows:**  
   1a. If the book does not belong to the reader, prompt: "Return failed. This book is not associated with your account";  
   2a. If overdue, prompt: "Overdue fine required: XX RMB";  
   3a. If status update fails, prompt: "System error. Please contact the administrator."  
   **Acceptance Criteria:**

* Book must be correctly associated with the reader account;
* Overdue fines are automatically calculated and added to the reader's account;
* Once returned, the book becomes immediately borrowable or reservable;
* Return records include return date and operator (e.g., self-service machine ID).

**3) Service Name: Calculate Overdue Fines**  
**Service Description:** As the system, I want to automatically calculate overdue fines to ensure timely book returns.  
**Triggering Events:**

* Book is returned past the due date;
* Daily scheduled scan of overdue records at 1:00 AM.  
  **Basic Flow:**

1. Calculate the number of overdue days (current date – due date);
2. Compute fine based on policy (e.g., 1 RMB/day, maximum 50 RMB);
3. Generate fine record (reader ID, book ID, amount, overdue days);
4. Update the reader's "outstanding fine" amount;
5. Notify the reader with fine details.  
   **Alternative Flows:**  
   1a. If due date is missing, log an error and skip processing;  
   2a. If fine rules are not configured, apply default rule (1 RMB/day).  
   **Acceptance Criteria:**

* Overdue days must be a positive integer;
* Fine amount must comply with predefined rules;
* Fine records must be persistently stored;
* Reader’s outstanding fine field is updated in real time.

**4) Service Name: Renew Book**  
**Service Description:** As a reader, I want to renew borrowed books to extend the loan period.  
**Triggering Event:** The reader clicks the "Renew" button in the system interface.  
**Basic Flow:**

1. Validate whether the book is eligible for renewal (i.e., not reserved, not overdue, and remaining renewals > 0);
2. Extend the due date (original due date + renewal period, e.g., 15 days);
3. Decrease the remaining renewal quota (e.g., max one renewal per book);
4. Notify the reader of successful renewal.  
   **Alternative Flows:**  
   1a. If the book is reserved, prompt: "Renewal denied due to an active reservation";  
   2a. If renewal quota is exhausted, prompt: "Renewal limit reached."  
   **Acceptance Criteria:**

* Due date must be extended after renewal;
* Renewal record must include original borrow ID and new due date;
* Reader receives a renewal confirmation notification.

**5) Service Name: Reserve Book**  
**Service Description:** As a reader, I want to reserve borrowed books so that I can borrow them as soon as they are returned.  
**Triggering Event:** The reader clicks the "Reserve" button on the book details page.  
**Basic Flow:**

1. Confirm that the book status is "borrowed";
2. Check whether the reader has exceeded the reservation limit (e.g., max 3 books);
3. Record reservation details (reader ID, book ID, reservation timestamp, priority);
4. Set the book's reservation status to "true";
5. Notify the reader of successful reservation.  
   **Alternative Flows:**  
   1a. If the book is available, prompt: "Reservation unnecessary. You may borrow it now";  
   2a. If reservation limit is reached, prompt: "Maximum of 3 active reservations allowed."  
   **Acceptance Criteria:**

* Only "borrowed" books may be reserved;
* Reservation queue must be sorted by timestamp (priority);
* Upon return, the system automatically notifies the top-priority reserver.

**6) Service Name: Search Book**  
**Service Description:** As a reader or administrator, I want to search for books to locate their availability and position.  
**Triggering Event:** User enters a keyword in the search bar and clicks "Search."  
**Basic Flow:**

1. Retrieve books using keywords (e.g., title, author, ISBN);
2. Return a result list (including title, author, status, shelf location);
3. Allow access to detailed view (borrowing history, reservation queue, fine history).  
   **Alternative Flows:**  
   1a. If no results are found, show: "No matching books found";  
   2a. If query times out, show: "Network busy, please try again later."  
   **Acceptance Criteria:**

* Support fuzzy search (e.g., "Harry" matches "Harry Potter");
* Results must be paginated (20 items per page);
* Details page must display book cover and summary (if available).

**7) Service Name: Pay Fine**  
**Service Description:** As a reader, I want to pay overdue fines to remove borrowing restrictions.  
**Triggering Event:** Reader clicks "Pay Fine" on the "My Account" page.  
**Basic Flow:**

1. Retrieve the amount of outstanding fines;
2. Integrate with payment gateway (e.g., Alipay, WeChat Pay, UnionPay);
3. Upon successful payment, update fine status to "paid";
4. Lift any borrowing restrictions on the reader.  
   **Alternative Flows:**  
   1a. If payment fails, prompt: "Payment failed. Please check your account balance";  
   2a. If payment gateway is unavailable, log the error and prompt: "System busy."  
   **Acceptance Criteria:**

* Payment amount must exactly match the outstanding amount;
* Generate an electronic receipt upon successful payment;
* Reader's outstanding fines field is cleared.

**8) Service Name: Manage Reader Account**  
**Service Description:** As an administrator, I want to manage reader accounts to ensure system security and data accuracy.  
**Triggering Event:** Administrator clicks "Add/Edit/Freeze Reader Account" in the backend system.  
**Basic Flow:**

1. Add reader: input name, ID number, and contact details;
2. Edit reader: update contact details or borrowing privileges;
3. Freeze account: disable borrowing/renewal for rule-violating users;
4. Log all operations (operator, timestamp, action type).  
   **Alternative Flows:**  
   1a. If ID number already exists, prompt: "Reader already registered";  
   2a. If required fields are missing, prompt: "Please complete all required fields."  
   **Acceptance Criteria:**

* Reader ID number must be unique;
* Frozen accounts cannot initiate borrowing or renewal operations;
* All actions must be recorded in an audit log.