DALHOUSIE
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CSCI 5411

Advanced Cloud Architecting

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Final – Term Project

Milestone – 01

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LoanSyncro: Loan Repayment Tracker

1. Introduction:

a. Project Overview

LoanSyncro is a modern, cloud-native web application designed to simplify the management of personal and small business loan repayments. The solution empowers users to monitor multiple loans, track outstanding balances, log repayments, and receive timely reminders for upcoming due dates—all within a secure and intuitive dashboard. Built on AWS's highly available, serverless infrastructure, LoanSyncro ensures users can access their financial data securely, anytime and anywhere.

b. Application Domain Selection & Justification

This project addresses a clear need within the personal finance and small business finance domains. Managing multiple loans, whether personal, educational, or business-related, is a widespread challenge.

Existing tools are either too complex, not secure enough, or lack automation for reminders and analytics. By leveraging AWS services, LoanSyncro provides an easy-to-use, reliable, and secure system that helps users stay on top of their financial obligations—minimizing missed payments and financial stress.

c. Problem Statement & Business Case

Many individuals and small business owners face difficulties tracking their loans and repayments. Manual tracking or the use of scattered spreadsheets often leads to missed payments, late fees, and negative credit impacts.

LoanSyncro delivers a centralized, cloud-based platform for comprehensive loan tracking. Users can add new loans, record repayments, and visualize their payment progress. Automated reminders reduce the risk of missed payments. As a result, users are better equipped to manage their debt, protect their credit scores, and make informed financial decisions. The scalable and cost-effective AWS serverless architecture ensures that LoanSyncro remains accessible, reliable, and affordable for all users.

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2. Functional Requirements Specification:

LoanSyncro provides the following core functionalities to deliver a seamless loan repayment management experience:

a. User Management

LoanSyncro provides secure and streamlined user management to ensure that each individual's data remains private and personalized. New users can register and create an account, while returning users can securely log in and out using robust authentication mechanisms. Once authenticated, users have access to their personal profile, where they can update essential information such as their contact details or notification preferences. This foundation supports individualized experiences and enables features like tailored reminders and secure data access.

b. Loan Management

Users can efficiently manage all their loans within a single platform. When adding a new loan, the application collects essential information, including the loan's name or type, the principal amount, applicable interest rates, repayment schedule (such as frequency, start and end dates), and lender details if needed. LoanSyncro maintains an organized overview of all active and past loans, allowing users to view key details at a glance. Additionally, users are empowered to edit the specifics of any loan if terms change, or delete loans that are no longer relevant, providing flexibility and control over their financial commitments.

c. Repayment Tracking

Tracking repayments is a core capability of LoanSyncro. Users can log each payment they make against any loan, specifying important information such as the repayment amount, date of payment, and—optionally—the payment method used. For every loan, the system maintains a complete repayment history, making it easy for users to reference past payments. As repayments are logged, the outstanding balance for each loan is updated automatically, helping users always understand their real-time financial position and progress toward payoff.

d. Dashboard and Analytics

A personalized dashboard delivers an at-a-glance summary of the user's overall financial status. This includes clear metrics like the total amount borrowed, total amount repaid, current outstanding balances, and a schedule of upcoming payments. LoanSyncro's dashboard also features visual charts and graphs to help users quickly interpret repayment trends, compare balances between different loans, and monitor their payment history over time. Users have the option to filter the dashboard based on specific loans, timeframes, or loan status, ensuring the analytics are always relevant and actionable.

e. Notifications and Reminders

To prevent missed payments and promote financial responsibility, LoanSyncro includes an automated notification system. Users receive timely email or SMS reminders ahead of upcoming repayment due dates, as well as alerts if a payment becomes overdue. The application allows users to customize their reminder preferences, such as the preferred notification channel and frequency, so they receive alerts in the most convenient way possible.

f. Data Export

Recognizing the importance of personal financial records, LoanSyncro enables users to export or download a complete history of their loans and repayments. Data can be exported in commonly used formats, such as PDF, supporting users in their own reporting, tax preparation, or record-keeping needs.

g. Security and Privacy

LoanSyncro is built with privacy and data protection as core priorities. All user data is encrypted during transit and while at rest within the system. Only authenticated users can access or make changes to their own data, with user sessions managed via secure token-based authentication. This rigorous approach to security safeguards user information from unauthorized access and maintains trust in the platform.

3. Non-Functional Requirements Analysis:

LoanSyncro is designed to address all critical non-functional requirements, each mapped to the AWS Well-Architected Framework's six pillars to ensure the platform is robust, secure, efficient, and future-ready.

3.1 Availability (Reliability, Operational Excellence)

LoanSyncro leverages AWS managed services—such as Lambda, DynamoDB, Cognito, and API Gateway—which automatically replicate data and workloads across multiple Availability Zones. This multi-AZ architecture, combined with Amplify's use of AWS's global CDN, maximizes uptime and ensures the application remains accessible even if localized failures occur.

3.2 Reliability (Reliability, Operational Excellence)

Reliability is maintained through DynamoDB's built-in redundancy and point-in-time recovery features, protecting all persistent data. CloudWatch actively monitors each component, sending alerts for anomalies. Infrastructure as Code (Terraform) ensures rapid, consistent restoration of the environment in the event of failures, supporting robust disaster recovery plans.

3.3 Performance (Performance Efficiency)

LoanSyncro optimizes performance by employing serverless Lambda functions and scalable DynamoDB storage. Both components scale automatically with workload, ensuring fast response times during both regular and peak usage—such as end-of-month repayment surges. API Gateway efficiently routes requests, maintaining low latency throughout.

3.4 Scalability (Performance Efficiency, Scalability)

The architecture is fully serverless and elastic. All major services, including Lambda, DynamoDB, and API Gateway, scale automatically to match demand without manual intervention. This ensures consistent service quality and responsiveness regardless of user base size or usage spikes.

3.5 Security (Security)

Security is enforced throughout LoanSyncro using Cognito for user authentication and authorization, encrypted data in transit (HTTPS) and at rest (DynamoDB, S3), and least-privilege IAM roles for all services. Sensitive information, secrets, and environment variables are securely managed. CloudWatch monitors for unusual activities, further strengthening the security posture.

3.6 Cost Optimization (Cost Optimization)

By adopting a pay-as-you-go serverless model, LoanSyncro ensures that costs only accrue for actual usage—eliminating expenses for idle resources. DynamoDB's on-demand mode and Lambda's per-invocation billing help maintain cost efficiency during both peak and off-peak periods. CloudWatch billing alarms and regular usage reviews support ongoing budget control.

3.7 Sustainability (Sustainability)

The serverless approach minimizes over-provisioning and maximizes resource efficiency, supporting sustainability goals. LoanSyncro's use of managed AWS services benefits from Amazon's large-scale investments in renewable energy and green data centers, reducing the platform's overall environmental impact.

3.8 Disaster Recovery (Reliability, Operational Excellence)

DynamoDB's backup and point-in-time recovery protect against data loss, while S3 enables secure export and archival of key data. Automated Terraform scripts allow for fast, consistent redeployment of the entire infrastructure if needed, ensuring rapid recovery from any critical incident.

3.9 Infrastructure as Code (Operational Excellence)

LoanSyncro uses Terraform for Infrastructure as Code, enabling consistent, repeatable deployments and simplifying management across environments. Version control of Terraform scripts allows for easy auditing, rollback, and rapid infrastructure recovery, fully supporting operational excellence and disaster preparedness.

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4. Initial Architecture Design:

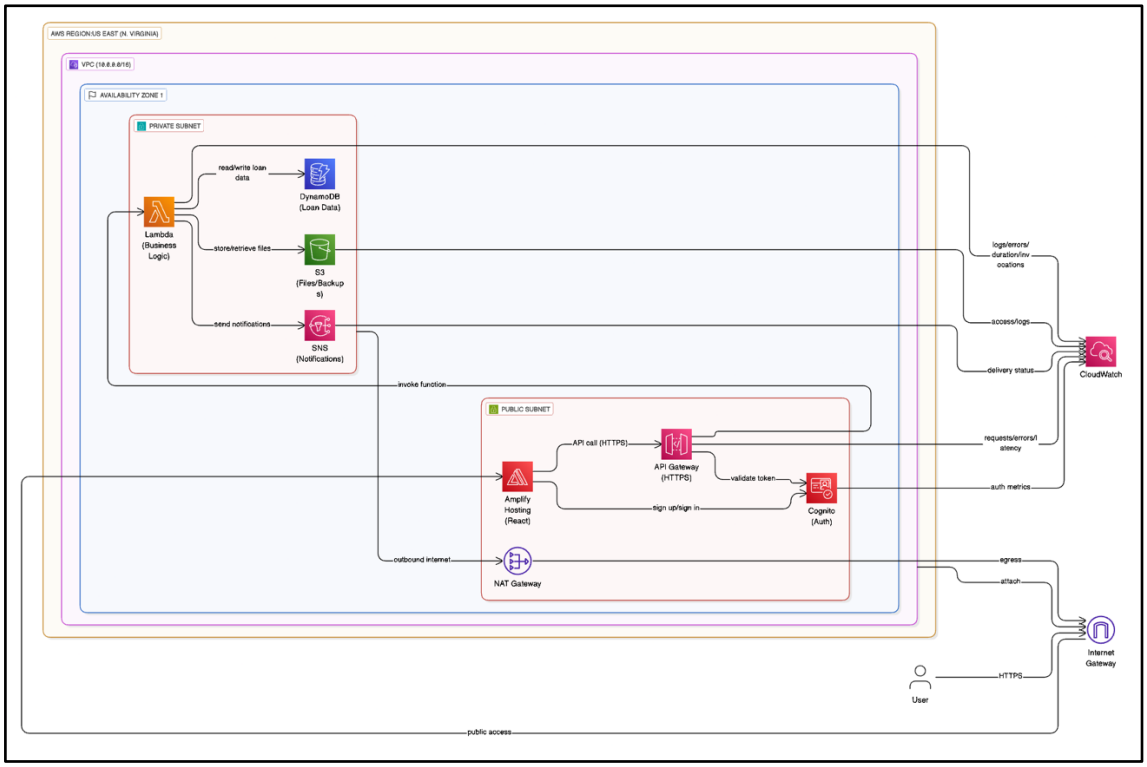

Fig. 1. Initial Architecture Diagram

The LoanSyncro architecture is fully serverless and leverages key AWS managed services to ensure security, scalability, and high availability. The frontend React application is hosted with AWS Amplify in a public subnet, accessible via an Internet Gateway, and all user authentication is managed by Amazon Cognito. API requests from the frontend are routed through API Gateway, which validates tokens before invoking Lambda functions running in private subnets. These Lambda functions interact with DynamoDB for storing and retrieving loan and repayment data, use S3 for file storage, and trigger SNS to send reminders. All system components are monitored by CloudWatch, with infrastructure spanning multiple Availability Zones to maximize uptime and fault tolerance.

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5. Data Sequence Diagram (UML):

The UML sequence diagram outlines the main flows in LoanSyncro: user login and dashboard retrieval, repayment submission, and automated repayment reminders. Users interact with the Amplify frontend, which handles authentication via Cognito and securely calls backend APIs. API Gateway validates user tokens and triggers Lambda functions for business logic, which in turn read from or write to DynamoDB, optionally store receipts in S3, and send notifications via SNS.

Logging and monitoring for every step are centralized in CloudWatch. This design ensures a seamless and secure data flow from user action through to persistent storage, analytics, and notifications.

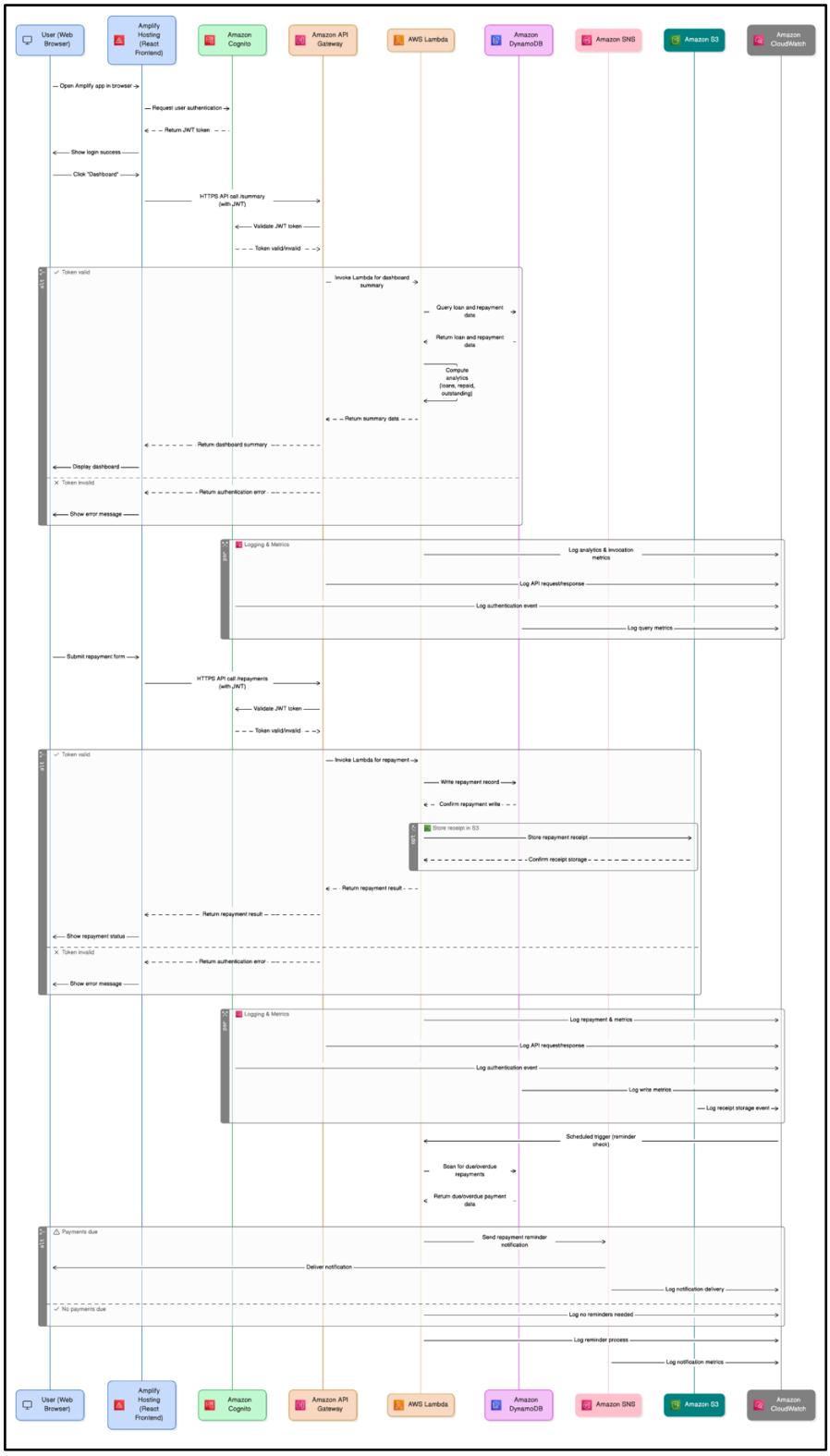

Fig. 2. Data Sequence Diagram (UML)

6. AWS Services & Tech Stack Used:

Services	Category	Purpose
AWS Lambda	Compute	Executes backend business logic (serverless functions)
Amazon DynamoDB	Database	Stores loan, repayment, and user data
Amazon S3	Storage	Stores files, exports, and optional data backups
Amazon API Gateway	Networking & Content Delivery	Exposes RESTful APIs for frontend-backend communication
Amazon Cognito	Security, Identity & Compliance	Handles user authentication and authorization
AWS Amplify	Developer Tool	Hosts and manages the React frontend
Amazon SNS	Application Integration	Sends email/SMS payment reminders to users
Amazon CloudWatch	Management & Governance	Centralized logging, metrics, and monitoring

Table. 1. AWS Services Used in LoanSyncro

Component	Technology/Tool	Purpose
Frontend	Any React Framework (Next.js or React.js)	Responsive, interactive user interface.
Backend	Python	Lambda function implementation.
API Design	RESTful API	Structured, documented backend APIs.
Authentication	AWS Cognito	User sign-up, login, and session management.
Infrastructure as Code	Terraform	Automated provisioning of AWS resources.
Diagrams	Draw.io	Architecture & UML diagram creation.
Version Control	Github	Code and IaC version management.

Table. 2. Tech-Stack Used in LoanSyncro

7. Initial Cost Analysis:

Services	Usage Estimation	Cost
AWS Lambda	100,000 invocations, 128MB, 100ms average	$0.30
AWS API Gateway	100,000 HTTP API call	$0.70
AWS DynamoDB	1GB storage, minimal reads/writes	$2.20
AWS S3	2GB storage, low access	$0.25
AWS SNS	200 SMS, 400 email notifications	$2.00
AWS Amplify	2GB hosting, 100 build mins	$0.50
Amazon Cognito	100 monthly active users	$1.80
Amazon CloudWatch	1GB logs, basic monitoring	$2.00
Total		**$9.75 (after cost optimization)**

Table. 3. Initial Cost Analysis of LoanSyncro

Note – Might change later after implementation.

8. Potential Architectural Challenges:

Managing Peak Load: Ensuring Lambda and DynamoDB can handle sudden spikes in user activity, such as simultaneous repayments or mass notification events.

Cost Control: Staying within free tier and preventing unexpected expenses, especially with high notification or database usage.

Authentication Flows: Handling token expiration, refresh, and seamless single sign-on using Cognito across devices.

Data Consistency: Maintaining atomic updates and consistency in repayment and loan records, particularly during concurrent operations.

Notification Reliability: Guaranteeing delivery of payment reminders via SNS, and handling failed or delayed notifications.

Monitoring and Alerting: Setting up effective CloudWatch alarms to detect and respond quickly to system errors or performance issues.

Disaster Recovery: Automating and regularly testing backup and restore processes to recover from data loss or system failures.

Infrastructure Automation: Managing complex resource dependencies and update sequencing using Terraform, especially during iterative development.

Scalability Limits: Identifying any soft or hard service limits (Lambda concurrency, DynamoDB throughput) that could impact future growth.

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9. Conclusion and References:

LoanSyncro is designed as a robust, scalable, and secure cloud-native solution for streamlined loan and repayment management. By leveraging AWS's managed serverless services, the architecture ensures high availability, cost-effectiveness, and operational efficiency, while adhering to the principles of the AWS Well-Architected Framework. The system's modular design supports seamless scaling and future enhancements, making LoanSyncro a practical and forward-looking platform for individual and small business users. The project's foundation—Infrastructure as Code, strong authentication, automated monitoring, and reliable data handling—ensures both technical soundness and real-world usability.

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