CSE326
Layered Architecture

B2 Group 1

Architecture Overview

Campus Connect is a sophisticated social platform designed for BUET students, featuring a multi-layered architecture that supports complex functionalities including social networking, intelligent recommendations, advanced search, and automated profile data synchronization.

Proposed Layers

1. **Presentation Layer** (User Interface)
2. **Business Logic Layer** (Core Services)
3. **Persistence Layer** (Data Access)
4. **Database Layer** (Data Storage)
5. **Integration Layer** (External Services)
6. **Infrastructure Layer** (Deployment and Operation)

Presentation Layer

This layer facilitates user interaction and serves as a uniform gateway to the backend services. It guarantees that students, teachers, and alumni encounter a straightforward and accessible interface, while also ensuring that requests are directed correctly.

Presentation Layer

- **User Interface Components:**
  - **Profile Management Screen**: UI to view and manage profile and related informations.
  - **News Feed Interface**: A responsive user friendly interface highlighting relevant posts to user from recommender system.
  - **Messaging System**: Sleek user interface for private messaging between users
  - **Search Interface**: Displays results fetched by search service with option to interact with them
  - **Registration System**: Handles registration, verification, two factor authentication for students, teachers and alumni.
- **Technology**
  - **ReactJS**(A framework that leverages component based development, thus ensuring modular and robust codes along with sleek user interface.

Presentation Layer: Components

- **API Gateway**: A single entry point to the project. Routes requests to specific services of backend
  - **Technology**: **Spring Cloud Gateway**

- **Reverse Proxy**: An intermediate between original server and client. Hides servers real IP for security, forwards traffic to appropriate server in distributed system
  - **Technology**: **NGINX** for reverse proxy

Business Logic Layer

In **CampusConnect**, the **business layer** handles core functionalities such as user authentication, connection requests, post recommendations, and job applications.This layer ensures data integrity, processes complex queries, and interacts with the database while remaining independent of the frontend and infrastructure layers.

Business Logic Layer

- **ProfileService**:
  - Handles creation and management of user profile and publicly visible data
- **PostManagementService**:
  - Create new posts
  - Like or comment on posts
- **MessagingService**:
  - Send or receive private texts to/fro other users
- **AuthenticationService**:
  - Verify user credentials

Business Logic Layer

- **NotificationService**:
  - Send notification to user when new message arrives or new interaction happens on user's post. Also sends verification request from other users.
- **RecommendationService**:
  - Runs ML based recommendation algorithms
  - Collects users interaction(like, comments, search keywords) data.
  - Provides personalised content recommendation on news feed
  - Filters and ranks contents based on preexisting knowledge base and user interaction data

Business Logic Layer

- **SearchService**:
  - Provides relevant results from structured searched queries.
  - Filters and ranks based on user's profile data
- **AdvancedSearchService**:
  - Natural Language Processing Capabilities
  - LLM powered query processing
  - Semantic search mechanism
  - Fine tuned on platform specific data

Business Logic Layer

- **WebCrawler**:
  - External source profile data synchronization
  - Support for range of external sources
    - github.com
    - linkedin.com
    - facebook.com
    - Personal websites
  - Data extraction and filtering
  - Conflict resolution with existing data
  - Periodic sync mechanism

Business Logic Layer

Technology:

- **Java Spring Boot**
  - Industry standard robust backend technology
- **Java OAuth2**
  - Authentication and authorization
- **Spring Security**
  - Application level security
- **ScraPy**
  - For data scrapping
- **FlaskAPI**

Business Logic Layer

- **LangChain**
  - LLM Integration
- **Pre-trained LLM Models**
  - OpenAI
  - Anthropic
  - BERT

Persistence Layer

Persistence Layer or the **Data Access Layer** in **CampusConnect** acts as an intermediary between the database and the business logic. It provides a structured way to perform CRUD operations, such as retrieving user profiles, fetching recommended posts, managing research group memberships, and handling job applications. By abstracting direct database interactions, it simplifies queries, enhances security, and improves maintainability.

Persistence Layer

- **Components**:
  - **Objects** to handle CRUD operation abstracting out complexities within database level access
    - User
    - Post
    - Notification
    - Message
    - Recommender
    - SearchResults
    - Crawler
  - **Technology**:
    - **Hibernate ORM**
    - **Redis Cache Server -** for faster query response

Database Layer

Database Layer serves as the primary storage system for user profiles, posts, messages, connections, job applications, and research group details. It ensures data persistence, supports efficient querying, and maintains relationships between entities like students, teachers, and alumni. This layer is designed for scalability, integrity, and optimized retrieval of structured data.

Database Layer

- **Primary Database**:
  - Stores user profiles, connections, posts, interactions, notifications in appropriate tables in a RDBMS.
    - **Technology**:
      - **MySQL**
- **Vector Database:**
  - Vector DB with indexes to store vector embeddings for faster better search and recommendation results
  - Alike to RDBMS, but stores vector embeddings instead
    - **Technology**:
      - **Pinecone**

Database Layer

- **Backup Database**:
  - A backup of primary database in case of primary database failure
  - Asynchronously copies the primary database time to time.
    - **Technology**:
      - **MySQL**

Integration Layer

Integration Layer (API Layer) in **CampusConnect** manages communication between the system and external services.

Integration Layer

Components:

- **SMS/Email notification service**
  - Uses third party services to send OTP or verification texts
  - **Twilio**
- **Third Party OAuth Providers**
  - Login with Google
  - Login with Github
  - Login with LinkedIn

Infrastructure Layer

Ensures reliable hosting, runtime environment, scalability, load balancing, networking, and security, supporting all other layers to deliver a secure, high-performing, and scalable platform. This layer manages cloud infrastructure, containerization, and database hosting while implementing security measures like encryption, firewalls, and DDoS protection. It enables efficient resource allocation, auto-scaling, and fault tolerance to maintain system stability under varying loads.

Infrastructure Layer

- **Hosting Platform**:
  - Offers scalability, security, and high availability for running the application
    - **Technology**:
      - Google Cloud SQL for MySQL
      - Google Cloud Memory Store for Redis
      - Google Kubernetes Engine
      - Cloudfare for DNS management and DDoS protection
      - Google Cloud Storage for static files like images

Infrastructure Layer

- **Container**:
  - Containers are self-sufficient, lightweight packages that bundle an application with its code, runtime, libraries, system tools, and configurations, ensuring consistent and reliable execution across various environments.
  - **Technology**:
    - **Docker** for containerization
    - **Kubernetes** for orchestration
- **CI/CD Pipelining Tool**
  - Automated integration, deployment, and testing ensures fast deployment of new fixes and features.
  - **Technology**:
    - **Jenkins** for CI/CD Pipelining

Infrastructure Layer

- **Load Balancer**:
  - Enables the fair distribution of traffic across multiple servers.
  - **Technology**:
    - **Kubernetes** internal load balancer
- **Backup & Disaster Recovery Tool**
  - Ensures that data is securely backed up and can be restored in case of an outage or failure.
  - **Technology**:
    - Automated Backups for cloud storages

Infrastructure Layer

- **Monitoring & Logging Tool**
  - Integrates monitoring, logging, and alerting for tracking system health and troubleshooting issues.
  - **Technology**:
    - **Stackdriver (Google Cloud)** for logging and performance monitoring
    - **Prometheus/ Grafana** for more granular monitoring and setting up alerts

Thank you.