DEPARTMENT OF
COMPUTER SCIENCE & ENGINEERING
Discover. Learn. Empower.

Experiment 3

Student Name: Ankesh Amar **UID: 23BCS12463**
Branch: CSE **Section/Group: KRG 1-A**
Semester: 6th **Date of Performance:3/02/2026**
Subject Name: System Design **Subject Code: 23CSH-314**

1. **Aim**: To design a social media platform similar to Facebook or Instagram

2. **Objective**:

- To understand how a social media application works.
- To design both functional and non-functional requirements.
- To create the system architecture (High-Level Design – HLD).
- To design modules and classes (Low-Level Design – LLD).
- To implement core APIs for user authentication, posts, feed, likes, and comments.

3. **Tools Used:**

- Python – Used for implementing backend logic and URL generation algorithms.
- Flask – A lightweight web framework for developing RESTful APIs.
- Draw.io – Used for designing system architecture diagrams (HLD and LLD).

4. **System Requirements:**

A. Functional Requirements

- The client should be able to register and log in to the application.
- The client should be able to create posts such as text, images, and videos.
- The client should be able to follow other users or send friend requests.
- The client should be able to like and comment on posts.
- The client should be able to view a feed containing posts from users they follow.

B. Non-Functional Requirements

- **Scalability**
  The system should support up to 500 Million Daily Active Users (500M DAU).
- **Availability and Consistency**
  Since this is a social media application, Availability is prioritized over Consistency.

Reason:

If the application is not operational when required, there is no purpose in developing it. Minor delays in content propagation are acceptable compared to complete downtime.

Example: If Instagram is down for 1 hour, it is a major issue.

However, if a post takes 500 ms to reach followers while the system remains available, it is acceptable Hence:

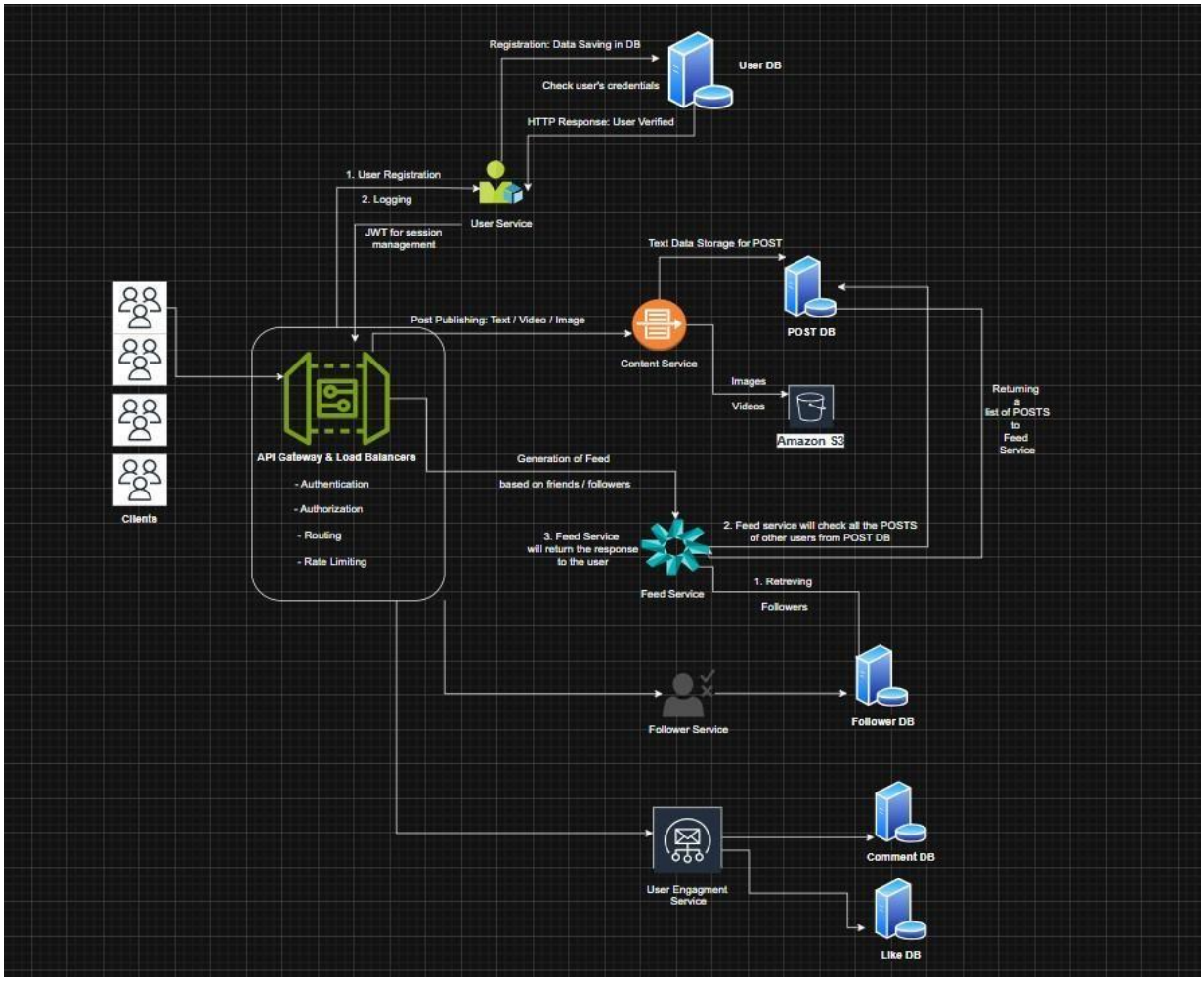
Availability >>> Consistency

- **Latency**

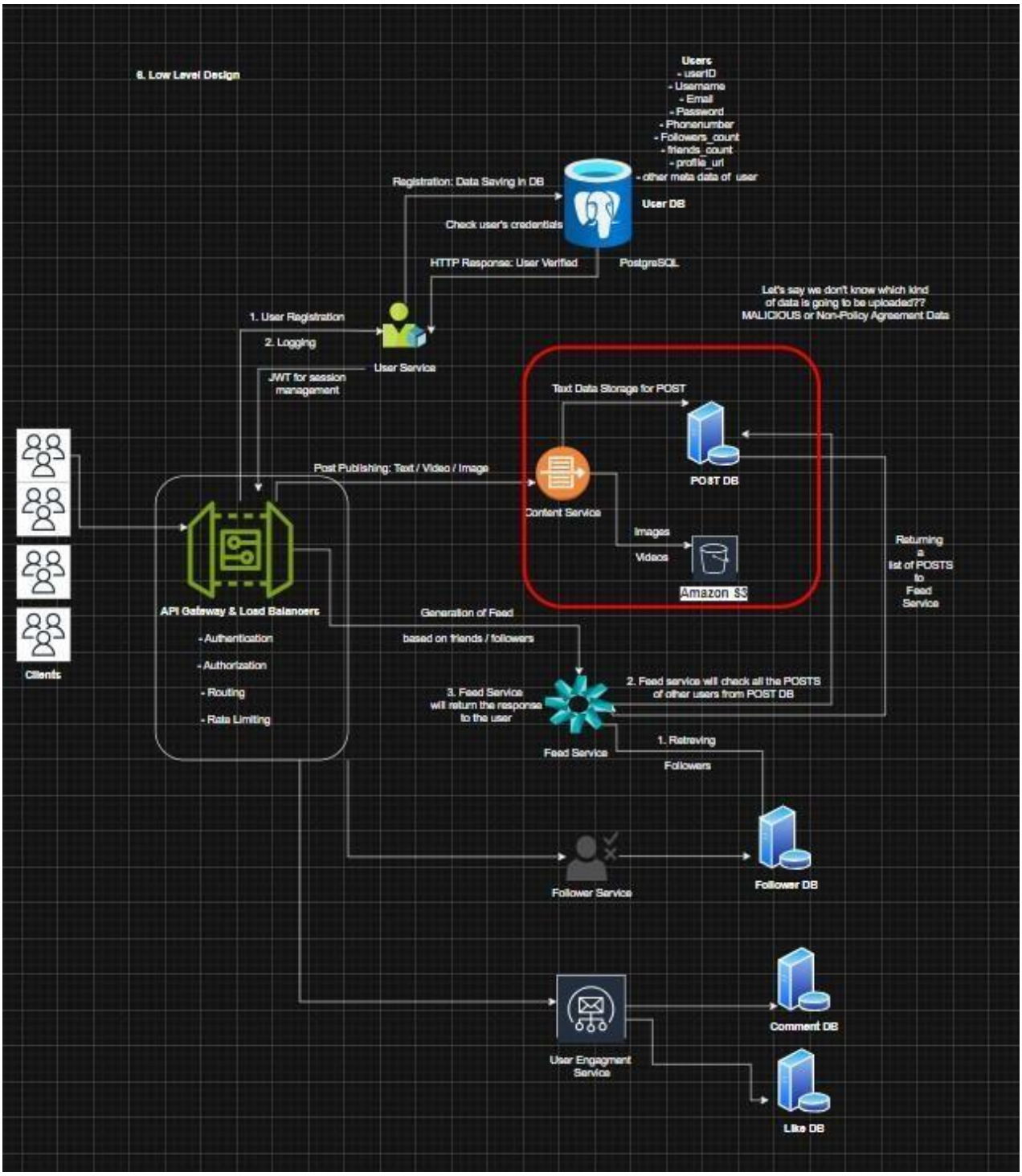
  Uploading or publishing a post should take approximately 500 milliseconds to ensure a smooth user experience.

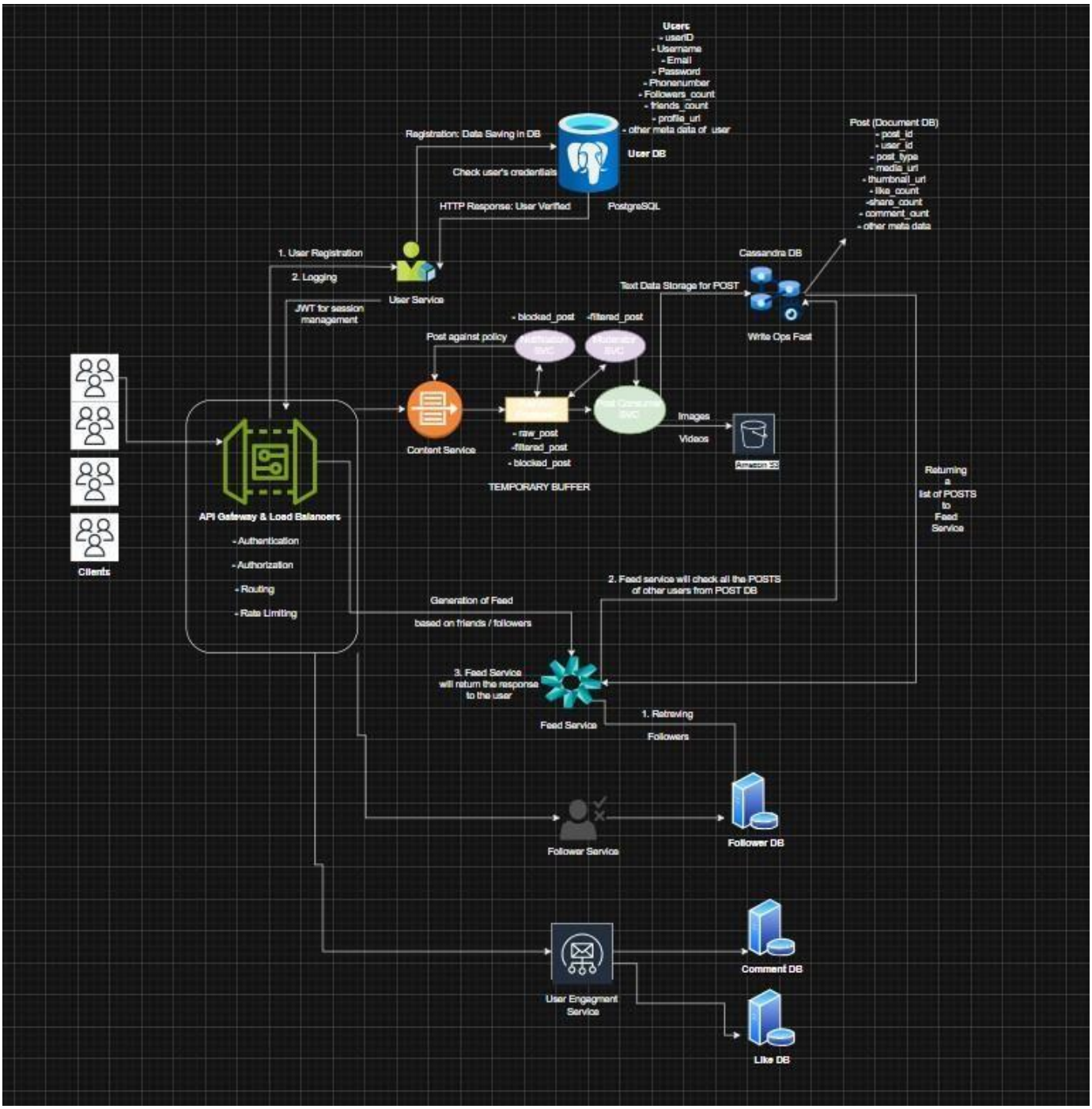
5. High Level Design (HLD):

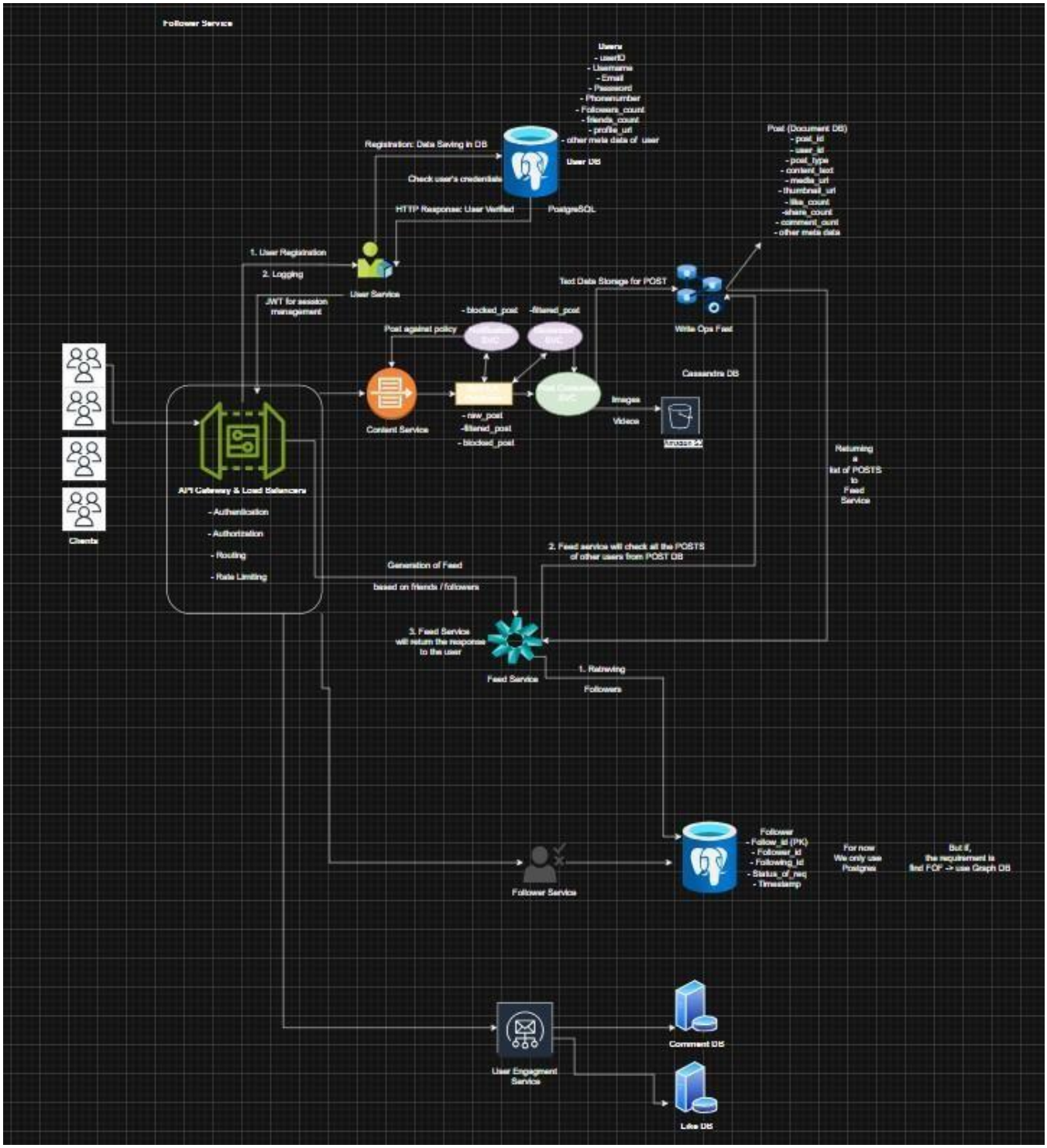
The system follows a MICRO-SERVICE ARCHITECTURE / DISTRIBUTED:



6. Low Level Design (LLD):




Users
- userID
- Username
- Email
- Password
- Phonenumber
- Followers_count
- friends_count
- profile_url
- other meta data of user
Registration: Data Saving in DB
User DB
Check user's credentials
HTTP Response: User Varified
PostgreSQL
Post (Document DB)
- post_id
- user_id
- post_type
- media_url
- thumbnail_url
- like_count
-share_count
- comment_cunt
- other meta data
1. User Registration
2. Logging
User Service
JWT for session management
Cassandra DB
Text Data Storage for POST
Write Ops Fast
- blocked_post
-filtered_post
Post against policy
Content Service
- raw_post
-filtered_post
- blocked_post
TEMPORARY BUFFER
Images
Videos
Amazon S3
Clients
API Gateway & Load Balancers
- Authentication
- Authorization
- Routing
- Rate Limiting
Returning a list of POSTS to Feed Service
2. Feed service will check all the POSTS of other users from POST DB
Generation of Feed
based on friends / followers
3. Feed Service will return the response to the user
Feed Service
1. Retreving
Followers
Follower Service
Follower DB
User Engagment Service
Comment DB
Like DB


Follower Service
Users
- userID
- Username
- Email
- Password
- Phonenumber
- Followers_count
- friends_count
- profile_url
- other meta data of user
Registration: Data Saving in DB
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Post (Document DB)
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Write Ops Feed
- blocked_post
-filtered_post
Post against policy
Cassandra DB
Content Service
- new_post
-filtered_post
- blocked_post
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Videos
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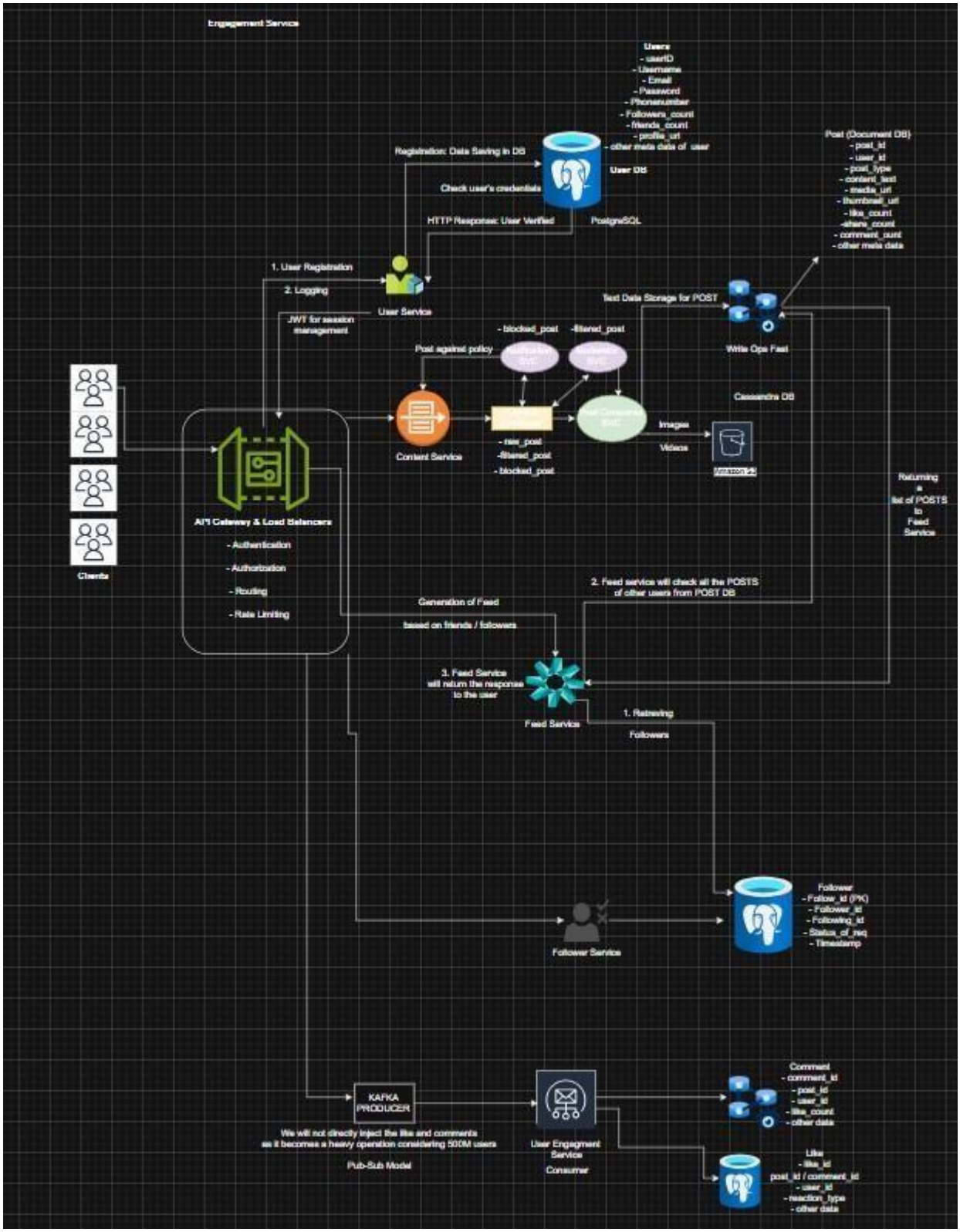
Feed Service
1. Retrieving
Followers
Follower
- Follow_id (PK)
- Follower_id
- Following_id
- Status_of_req
- Timestamp
For now We only use Postgres
But if, the requirement is find FOF -> use Graph DB
Follower Service
User Engagment Service
Comment DB
Like DB


Engagement Service
Users
- userID
- Username
- Email
- Password
- Phonenumber
- Followers_count
- friends_count
- profile_url
- other meta data of user
Registration: Data Saving in DB
User DB
Check user's credentials
PostgreSQL
HTTP Response: User Verified
Post (Document DB)
- post_id
- user_id
- post_type
- content_text
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Videos
Amazon s3
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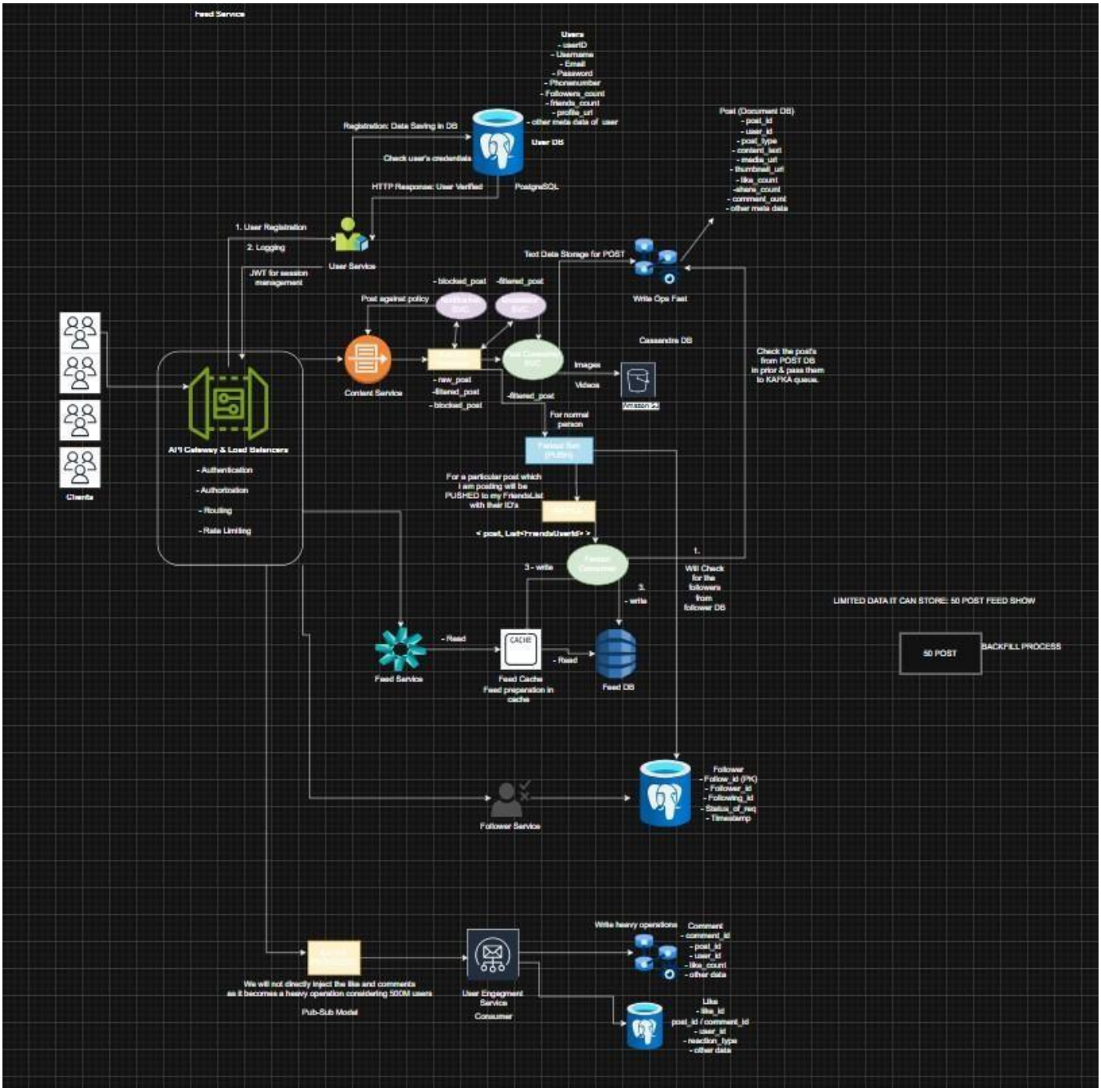
- Timestamp
Follower Service
KAFKA PRODUCER
We will not directly inject the like and comments as it becomes a heavy operation considering 500M users
Pub-Sub Model
User Engagement Service
Consumer
Comment
- comment_id
- post_id
- user_id
- like_count
- other data
Like
- like_id
post_id / comment_id
- user_id
- reaction_type
- other data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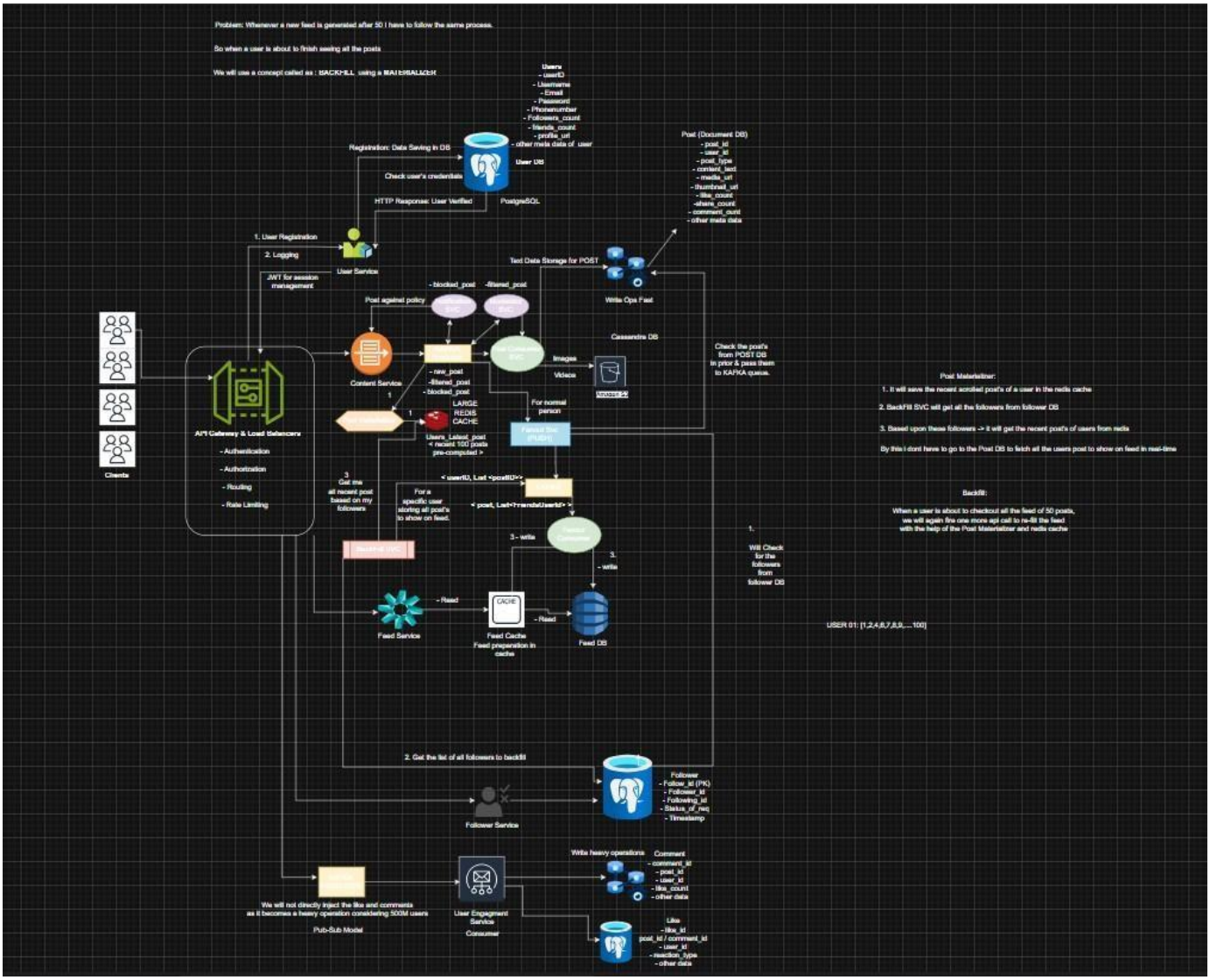
- blocked_post
-filtered_post
Post against policy
Cassandra DB
Images
Videos
Amazon S3
Check the post's from POST DB in prior & pass them to KAFKA queue.
Content Service
- raw_post
-filtered_post
- blocked_post
-filtered_post
For normal person
Clients
API Gateway & Load Balancers
- Authentication
- Authorization
- Routing
- Rate Limiting
For a particular post which I am posting will be PUSHED to my FriendsList with their ID's
< post, List<FriendsUserId> >
1.
Will Check for the followers from follower DB
3 - write
3.
- write
LIMITED DATA IT CAN STORE: 50 POST FEED SHOW
50 POST
BACKFILL PROCESS
- Read
CACHE
- Read
Feed Service
Feed Cache
Feed preparation in cache
Feed DB
Follower
- Follow_id (PK)
- Follower_id
- Following_id
- Status_of_req
- Timestamp
Follower Service
Write heavy operations
Comment
- comment_id
- post_id
- user_id
- like_count
- other data
We will not directly inject the like and comments as it becomes a heavy operation considering 500M users
Pub-Sub Model
User Engagment Service
Consumer
Like
- like_id
post_id / comment_id
- user_id
- reaction_type
- other data


Problem: Whenever a new feed is generated after 50 I have to follow the same process.
So when a user is about to finish seeing all the posts
We will use a concept called as : BACKFILL using a MATERIALIZER
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- userID
- Username
- Email
- Password
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- profile_url
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User DB
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Registration: Data Saving in DB
Check user's credentials
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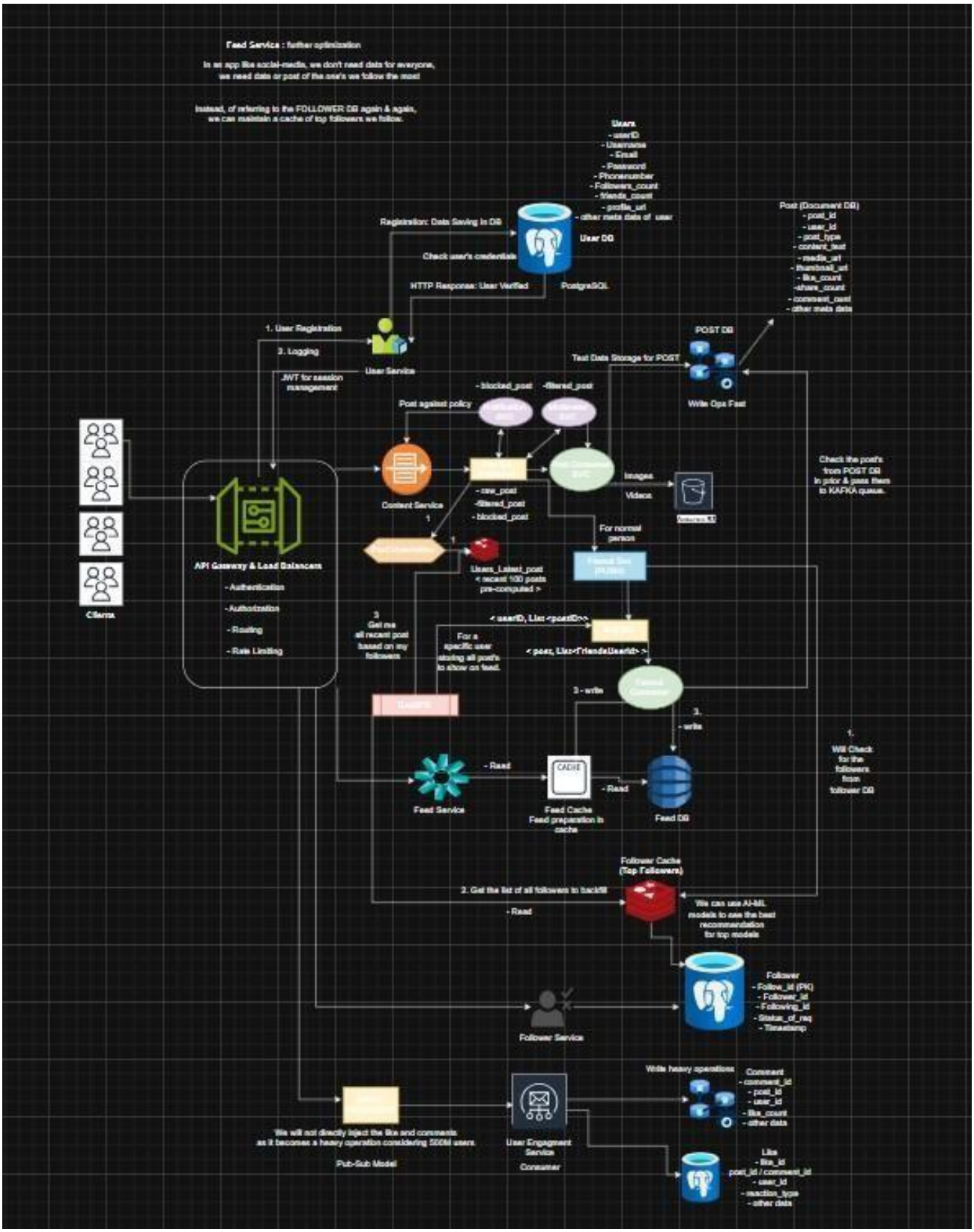
- new_post
-filtered_post
- blocked_post
Check the post's from POST DB in prior & pass them to KAFKA queue.
LARGE
REDIS
CACHE
Users_Latest_post
< recent 100 posts
pre-computed >
For normal person
Clients
API Gateway & Load Balancers
- Authentication
- Authorization
- Routing
- Rate Limiting
3
Get the all recent post based on my followers
For a specific user storing all post's to show on feed.
< userID, Last <postID>>
< post, Last<FriendsUserId> >
3 - write
3.
- write
1.
Will Check for the followers from follower DB
Post Materializer:
1. It will save the recent scrolled post's of a user in the redis cache
2. BackFill SVC will get all the followers from follower DB
3. Based upon these followers -> it will get the recent post's of users from redis
By this I dont have to go to the Post DB to fetch all the users post to show on feed in real-time
Backfill:
When a user is about to checkout all the feed of 50 posts,
we will again fire one more api call to re-fill the feed
with the help of the Post Materializer and redis cache
USER 01: [1,2,4,6,7,8,9,....100]
- Read
- Read
Feed Service
CACHE
Feed Cache
Feed preperation in cache
Feed DB
2. Get the list of all followers to backfill
Follower
- Follow_id (PK)
- Follower_id
- Following_id
- Status_of_req
- Timestamp
Follower Service
Write heavy operations
Comment
- comment_id
- post_id
- user_id
- like_count
- other data
We will not directly inject the like and comments as it becomes a heavy operation considering 500M users
Pub-Sub Model
User Engagment Service
Consumer
Like
- like_id
post_id / comment_id
- user_id
- reaction_type
- other data


Feed Service : further optimization
In an app like social-media, we don't need data for everyone, we need data or post of the one's we follow the most
Instead, of referring to the FOLLOWER DB again & again, we can maintain a cache of top followers we follow.
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- Phonenumber
- Followers_count
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Registration: Data Saving in DB
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Check user's credentials
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Post (Document DB)
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- user_id
- post_type
- content_text
- media_url
- thumbnail_url
- like_count
-share_count
- comment_cont
- other meta data
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2. Logging
User Service
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POST DB
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Users_Latest_post
< recent 100 posts pre-computed >
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- Routing
- Rate Limiting
Clients
3
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< userID, List<postID>>
< post, List<FriendsUserId> >
3 - write
3.
- write
1.
Will Check for the followers from follower DB
- Read
CACHE
- Read
Feed Service
Feed Cache
Feed preparation in cache
Feed DB
Follower Cache
(Top Followers)
2. Get the list of all followers to backfill
- Read
We can use AI-ML models to see the best recommendations for top models
Follower
- Follow_Id (PK)
- Follower_Id
- Following_Id
- Status_of_req
- Timestamp
Follower Service
Write heavy operations
Comment
- comment_id
- post_id
- user_id
- like_count
- other data
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Pub-Sub Model
User Engagement Service
Consumer
Like
- like_id
post_id / comment_id
- user_id
- reaction_type
- other data

7. Scalability Solution

- Use horizontal scaling by adding multiple application servers behind a load balancer.
- Implement database sharding to distribute user and post data across multiple databases.
- Use caching tools like Redis or Memcached to reduce database load for frequently accessed data such as feeds and user profiles.
- Store media files (images and videos) using cloud storage and a CDN to improve performance and reduce server load.
- Apply asynchronous processing and message queues like Kafka or RabbitMQ for tasks such as notifications and feed updates.

8. Learning Outcomes

- Understood how a social media application system works.
- Learned how to design functional and non-functional requirements.
- Gained knowledge of high-level and low-level system architecture.
- Learned how scalability and availability are achieved in large-scale systems.
- Developed an understanding of core APIs for user management, posts, and feed handling.