Design Proposal: Messenger Feature

This design outlines an approach for a chat application supporting real time and asynchronous messaging. The high level components are:

- API Gateway & Authorization Service - authorizes the user's credentials. For an unauthenticated user, or a revoked / unauthorized credentials token, it is assumed there is an existing login service we can redirect the user to.

- Messaging Service - The primary service for opening and persisting a chat connection. This is a load-balanced backend service (e.g. NodeJS), deployed via a Docker container to an EC2 cluster (or similar).

- List Service - Existing service to provide group messaging lists.

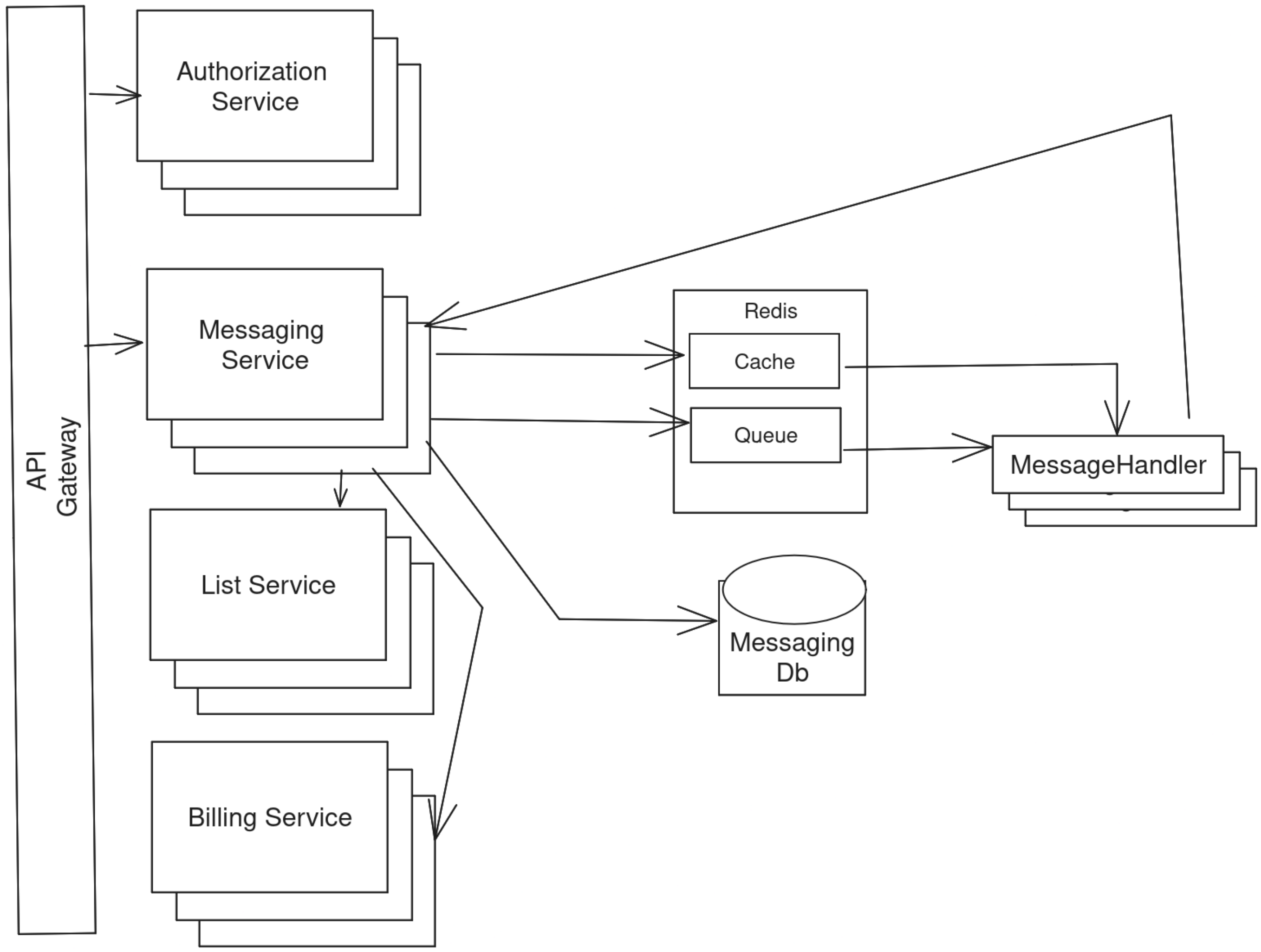
- Billing Service - Existing service to process payments.

- Redis Instance - Used as (1) a cache for tracking which users have active connections, and which specific server instances they are connected to. Also used as (2) a message queue for processing incoming messages.

- MessageHandler - An asynchronous task handler to process messages and tips, and to deliver them to the intended recipients.

- MessagingDB - A SQL database to store the messages and related data. This design requires two primary tables:

  1. A `messages` table to store the historical record of messages between users. This could include metadata such as read status, read_date, etc.
  2. A `blocked_users` table to track recipients that have blocked specific senders.



Real Time Chat

To achieve a real time chat, we will utilize WebSockets, Redis, and an asynchronous task processor.

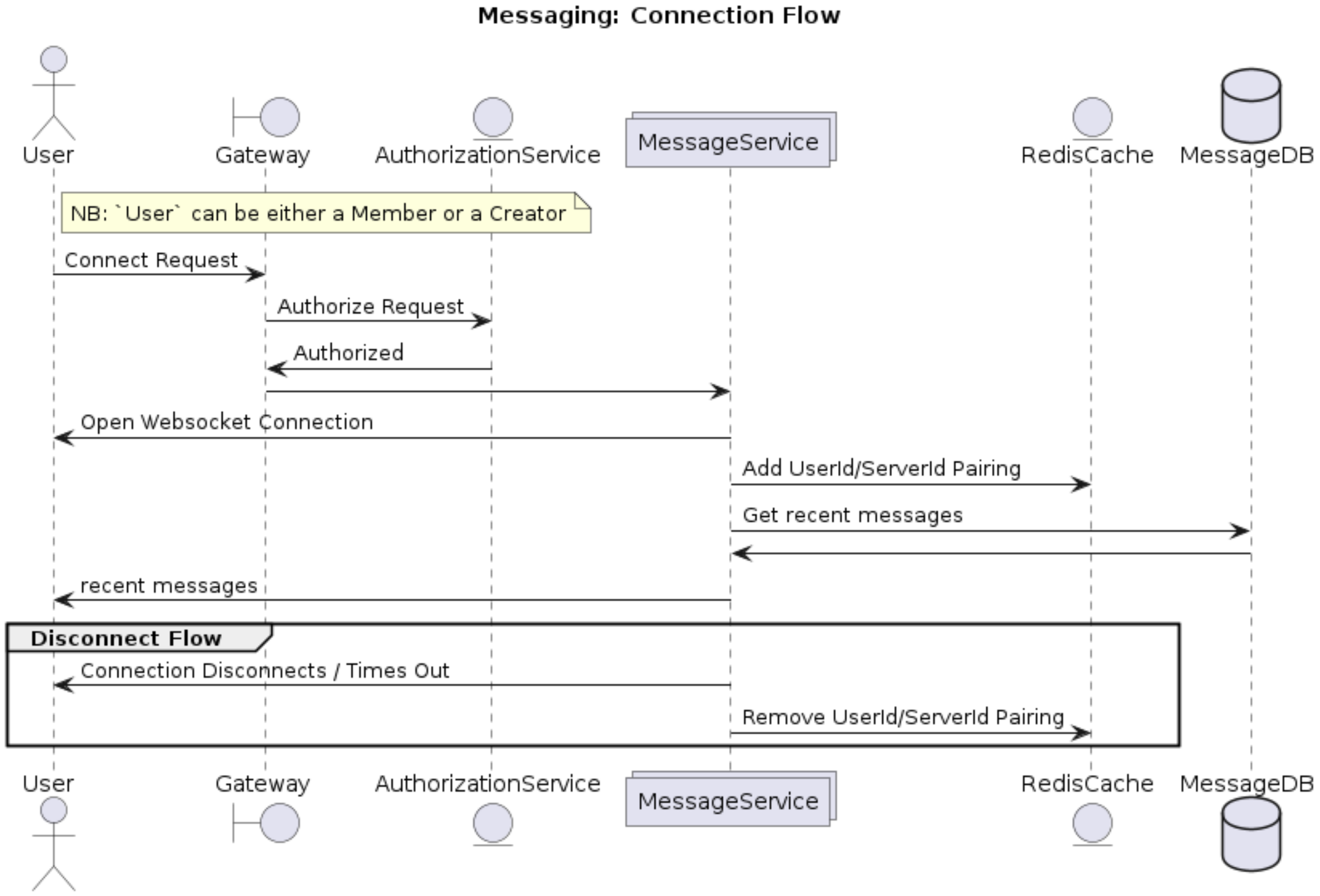
Initiating a Connection

When a user connects from the application (e.g. React application), the Gateway authorizes the connection via the provided credentials, forwards the request to an available MessageService instance, and opens the WebSocket connection.

Once the WebSocket connection is open, the MessageService stores an identifier in a shared Redis cache, so that new incoming messages can locate the server instance with the active connection.

Recent messages are loaded from the DB, and sent to the user over the newly established connection.

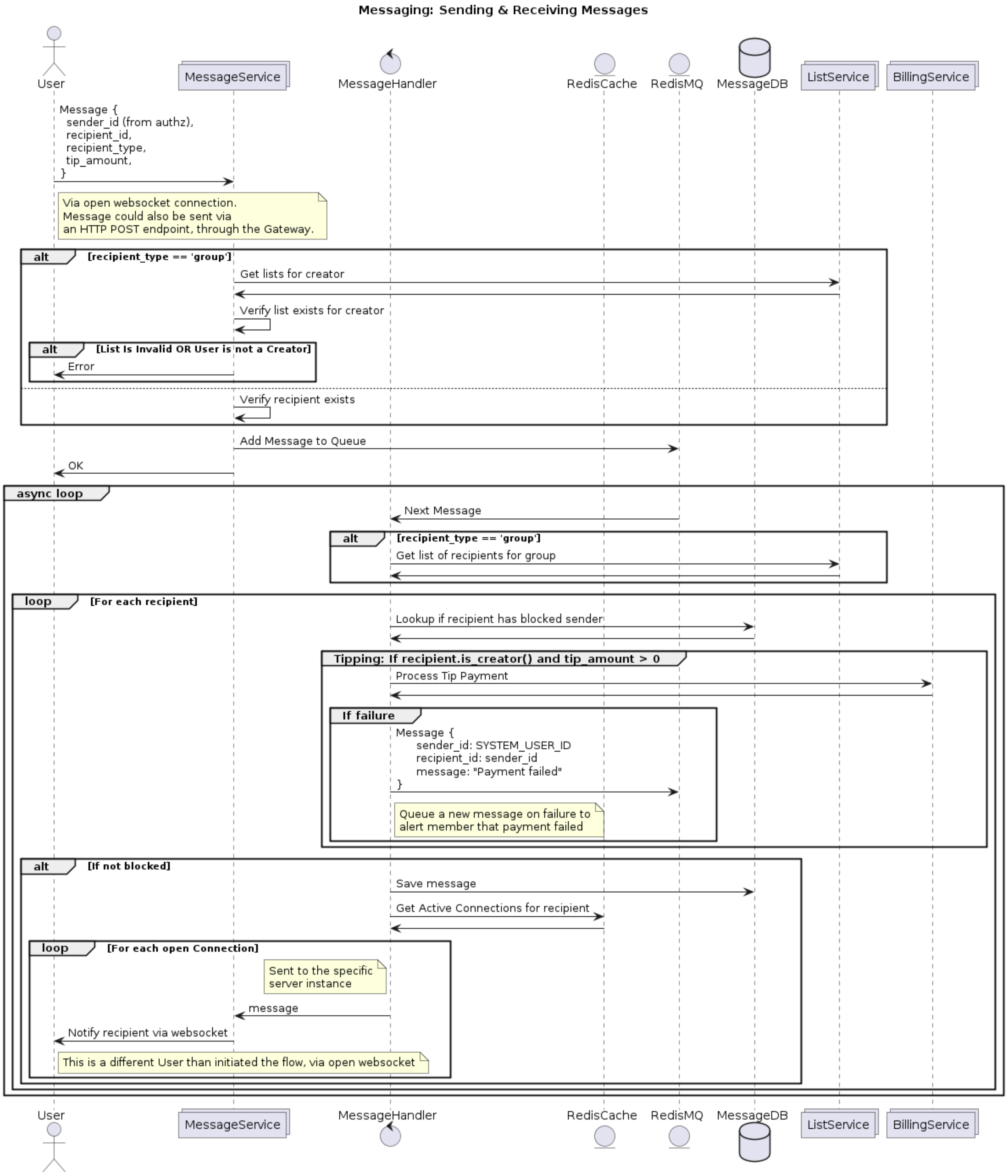
When the connection is terminated, the server instance removes the stale entry from the Redis cache.


Messaging: Connection Flow
User
Gateway
AuthorizationService
MessageService
RedisCache
MessageDB
NB: `User` can be either a Member or a Creator
Connect Request
Authorize Request
Authorized
Open Websocket Connection
Add UserId/ServerId Pairing
Get recent messages
recent messages
Disconnect Flow
Connection Disconnects / Times Out
Remove UserId/ServerId Pairing

Sending Messages

A message is sent via the open WebSocket connection (or via an HTTP endpoint) to the MessageService. The MessageService does basic filtering steps, such as (a) ensuring the recipient exists, and (b) ensuring the user is sending to a valid list belonging to them, if the user is a creator. It is then sent to a queue to be picked up by the async task processor, MessageHandler.

The MessageHandler will verify the recipient has not blocked the sender, store the message in the database, and notify the user by routing the message through MessageService via all active websocket connections.


Messaging: Sending & Receiving Messages
User
MessageService
MessageHandler
RedisCache
RedisMQ
MessageDB
ListService
BillingService
Message {
sender_id (from authz),
recipient_id,
recipient_type,
tip_amount,
}
Via open websocket connection.
Message could also be sent via
an HTTP POST endpoint, through the Gateway.
alt
[recipient_type == 'group']
Get lists for creator
Verify list exists for creator
alt
[List Is Invalid OR User is not a Creator]
Error
Verify recipient exists
Add Message to Queue
OK
async loop
Next Message
alt
[recipient_type == 'group']
Get list of recipients for group
loop
[For each recipient]
Lookup if recipient has blocked sender
Tipping: If recipient.is_creator() and tip_amount > 0
Process Tip Payment
If failure
Message {
sender_id: SYSTEM_USER_ID
recipient_id: sender_id
message: "Payment failed"
}
Queue a new message on failure to
alert member that payment failed
alt
[If not blocked]
Save message
Get Active Connections for recipient
loop
[For each open Connection]
Sent to the specific
server instance
message
Notify recipient via websocket
This is a different User than initiated the flow, via open websocket
User
MessageService
MessageHandler
RedisCache
RedisMQ
MessageDB
ListService
BillingService

Offline messaging

We achieve offline messaging by storing the messages in a relational database (e.g.

MariaDB), indexed on `recipient_id`, `sender_id`, and `sent_date`. This step is taken regardless of whether a message is sent, so that messages are not lost when a user closes the app. When a user logs in, they will receive all unread messages after the connection is established.

Messages could also be retrieved without engaging in live chat, via an HTTP endpoint that queries the MessageDB (not represented in diagram).

ref: See the Sending Messages sequence diagram above.

Out of Scope: Email, SMS, or other notifications could be sent when an offline user recieves a message by sending a notification after storing the new message in the database.

Mass messaging

Mass messaging is achieved through the same flow as individual messaging, with two added steps: When the message is sent, before being queued for processing, authorization checks are made against the sender and recipient list. The MessageHandler expands the list of recipients, and sends the message to each recipient via the MessageService instance with the active websocket connection.

ref: See the Sending Messages sequence diagram above.

Tipping

When a member tips a creator, it can be sent through the active websocket connection or via an HTTP endpoint. The request is made to the billing service - on success, the creator is notified with a message via the existing message flow. On failure, the member will receive a message with a link redirecting them to the Billing preferences to update their payment information.

It is assumed that tipping will be sent through the messaging flow, and that tips may include a message. An optional "tip amount" attribute is added to the request, and processed through the Billing service if it is nonzero.

ref: See the Sending Messages sequence diagram, this flow is outlined in the async loop section when processing messages.

Blocking

A user can block another user through an API call, which updates a `blocked_users` table in the MessageDB. Messages sent to a blocked user will not be processed. It is assumed that the user will not be notified that their messages are blocked, they will just be sent into the void.

To notify the user that their message has been blocked, we could instead do the block lookup when the message is received, before queueing it for processing.

Note: Blocked messages may be logged for investigative purposes and to prevent abuse. An alternate approach could also store the messages with a flag indicating it was blocked. Those messages would not be sent to the recipient, and would be filtered out when retrieving messages from MessageService (not represented in diagram)

Additional Considerations

- Integration tests and unit tests should be written as a part of the implementation.
- All services should include a Dockerfile with a release build.
- Infrastructure as Code (IaC) scripts should be written todefine the infrastructure and deployments.
- CICD workflows should be included to Build, Test, Release, and Deploy.
- Basic security controls are handled with the Authorization service and API Gateway, but more rigor and testing may be required.
- As traffic grows, to reduce strain on the primary DB an additional Redis cache could be added to cache frequently accessed data, such as block lists for high-traffic creators, messages for frequent users, or messages sent to very large groups.