Discord Clone — Full-Stack Real-Time Chat Application

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Project Overview

A desktop **Discord-style** chat platform built entirely from scratch. Users can join servers, switch channels, and exchange messages in real time.

- **Tech stack:** Node.js + Express (REST API), React 18 + Electron (desktop UI), PostgreSQL 14 (RDBMS), Socket.IO (WebSocket transport), Tailwind CSS (styling).

- **Key features:** full CRUD, threaded replies, optimistic UI, ACID-compliant schema, Recursive CTE for fetching complete threads, desktop installer via electron-builder.

Architecture

Layer	Technology	Highlights
Frontend	React 18 + Tailwind (in Electron)	Dark theme, server rail, channel list, message pane, reply banner
Realtime	Socket.IO	One room per channel, `message:new` broadcast to all clients
Backend	Node.js / Express	Controllers for CRUD, REST + JSON, global error handling
Database	PostgreSQL 14	Normalised schema, PK/FK constraints, recursive CTE for threads

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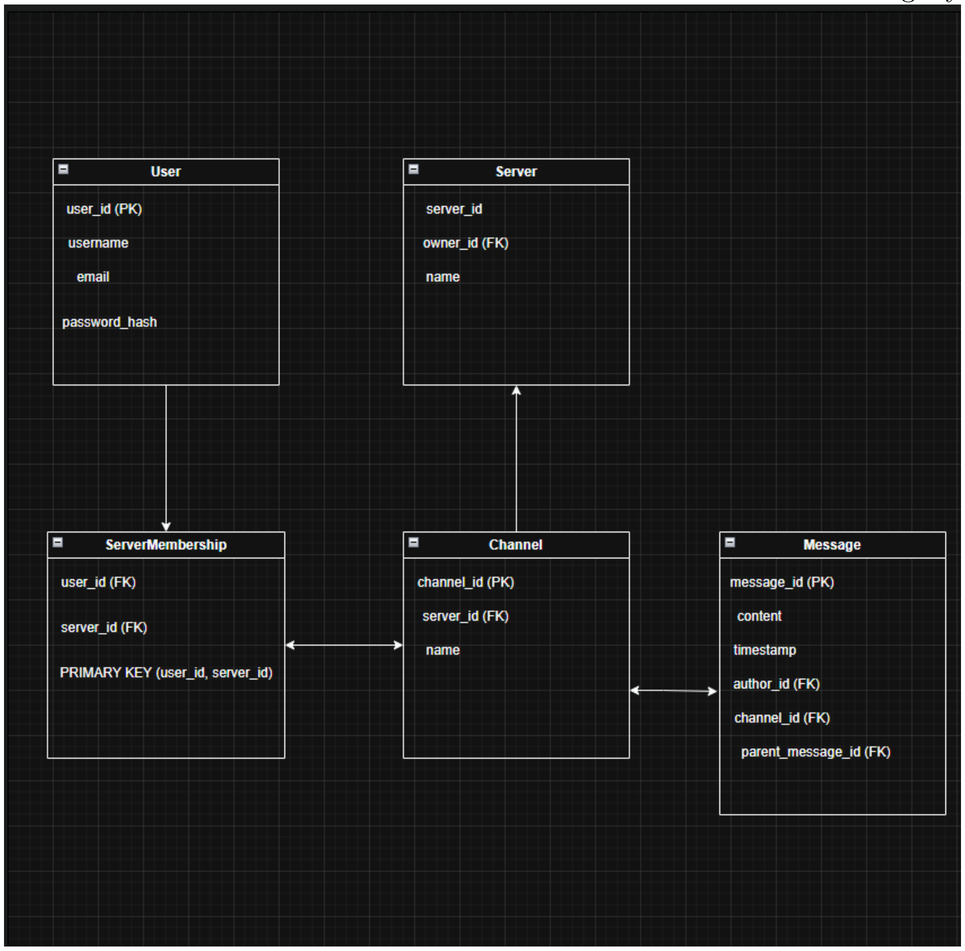
Entity–Relationship Diagram

Table highlights

* `messages.parent_message_id` self-FK that enables reply threads.
* `server_membership` composite PK (`user_id`, `server_id`) enforces one-membership-per-user-per-server.

* All FK columns `ON DELETE CASCADE` to maintain referential integrity.



ACID Compliance & Concurrency Control

- **Atomicity (A)** — Each endpoint performs a single SQL statement or an explicit transaction; failures roll back completely.
- **Consistency (C)** — PK/FK, `NOT NULL`, and unique indexes ensure only valid states persist.
- **Isolation (I)** — Default *READ COMMITTED* level prevents dirty reads; WebSocket events are sent **after** commit to guarantee clients

receive only durable data.

- **Durability (D)** — PostgreSQL WAL + `fsync` protect committed changes against crashes.

Concurrency note: UI is optimistic (adds message immediately), duplicates prevented by `message_id` uniqueness on subsequent `message:new` events.

Advanced SQL: Recursive CTE

Endpoint: `GET /messages/:id/thread`

```
WITH RECURSIVE thread AS (
    SELECT m.*, u.username
      FROM messages m
      JOIN users u ON u.user_id = m.author_id
     WHERE m.message_id = $1
  UNION ALL
    SELECT c.*, u2.username
      FROM messages c
      JOIN thread t ON c.parent_message_id = t.message_id
      JOIN users  u2 ON u2.user_id = c.author_id
)
SELECT * FROM thread ORDER BY timestamp;
```

Fetches root + all descendants in a single call → zero N+1 queries.

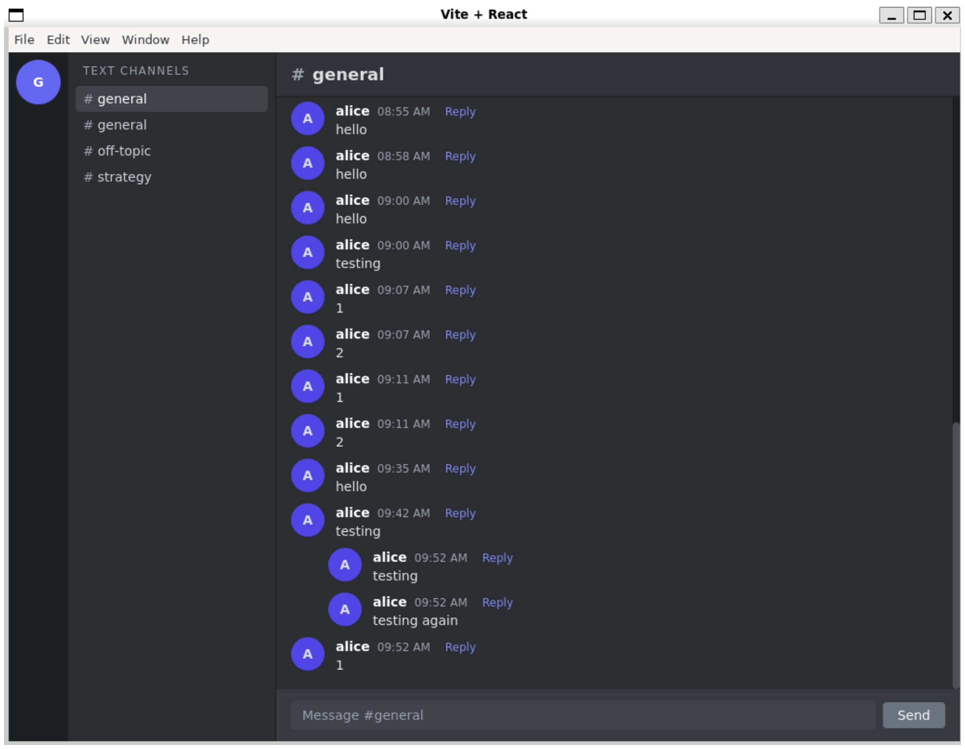
Demonstration Queries

File **`database/queries.sql`** contains eight test cases:

#	Purpose	Lines
1	Create new user	1–4
2	Create server + auto-membership	7–16
3	List servers for user 1	22–27
4	List messages with author names	30–38
5	Update channel name	41–44

#	Purpose	Lines
6	Delete messages older than 30 days	47–50
7	Recursive thread query	55–69
8	Aggregate messages per channel	74–82

Screenshots



alice 08:55 AM Reply
hello

alice 08:58 AM Reply
hello

alice 09:00 AM Reply
hello

alice 09:00 AM Reply
testing

alice 09:07 AM Reply
1

alice 09:07 AM Reply
2

alice 09:11 AM Reply
1

alice 09:11 AM Reply
2

alice 09:35 AM Reply
hello

alice 09:42 AM Reply
testing

alice 09:52 AM Reply
testing

alice 09:52 AM Reply
testing again

alice 09:52 AM Reply
1

Message #general

Figure 1 – Desktop Electron client showing real-time chat and thread reply.

Reproducibility Notes

1. `psql < database/schema.sql && psql < database/sample_data.sql`
2. `cd backend && npm install && npm start`

3. `cd desktop_app && npm install && npm run dev`
4. Login as *alice* → see live chat across two windows.
