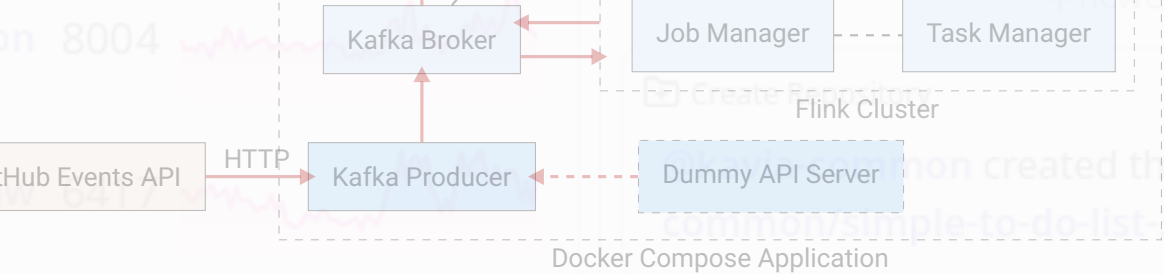


Final Presentation – Real-Time Big Data Processing 2024/2025

Real-Time Analysis of Public GitHub Activity

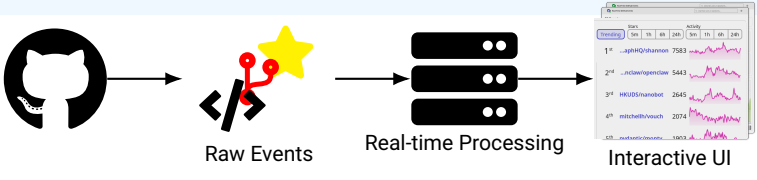
Roland Bernard

Febuary 2026

Application Domain

- Motivation and Context:
  - → GitHub hosts millions of developers and repositories.
  - → Generates large volumes of public events.
  - → Most existing tools focus mainly on historical analysis.

- Project Objectives:
  - → Collect GitHub events continuously.
  - → Process data in real time.
  - → Provide interactive dashboard.
  - → Ensure low latency and reliability.



Description of the Data Sources

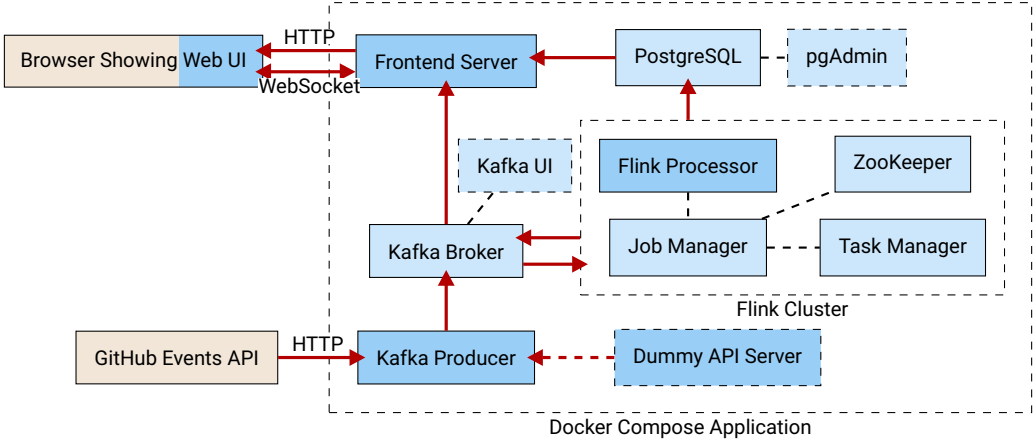
- GitHub Events API:
  - → Endpoint: `https://api.github.com/events`.
  - → Up to 300 most recent public events in JSON format.
  - → Rate limited, i.e., access token required.

- Key Properties:
  - → Variety: many event types, e.g., push, issues, stars, etc.
  - → Velocity: up to 120 events/sec, millions of events per day.
  - → Veracity: out-of-order and delayed events.
  - → Latency: API around 5 minutes behind real time.


```
{
  ”id”: ”8251545586”,
  ”type”: ”PushEvent”,
  ”actor”: {
    ”id”: 121951544,
    ”login”: ”movieflixgr”,
    ”display_login”: ”movieflixgr”,
    ”gravatar_id”: ””,
    ”url”: ”https://api.github.com/users/[
    ”avatar_url”: ”https://avatars.github[
  },
  ”repo”: {
    ”id”: 1126450259,
    ”name”: ”movieflixgr/Subtitles”,
    ”url”: ”https://api.github.com/repos/[
  },
  ”payload”: {
    ”repository_id”: 1126450259,
    ”push_id”: 30546526697,
    ”ref”: ”refs/heads/main”,
    ”head”: ”d5e986993aa47729cb18a82ac9d1[
    ”before”: ”6bf91f2d0600084cc7218c1934[
  },
  ”public”: true,
  ”created_at”: ”2026-02-
08T20:09:50Z”
}
```

System Architecture

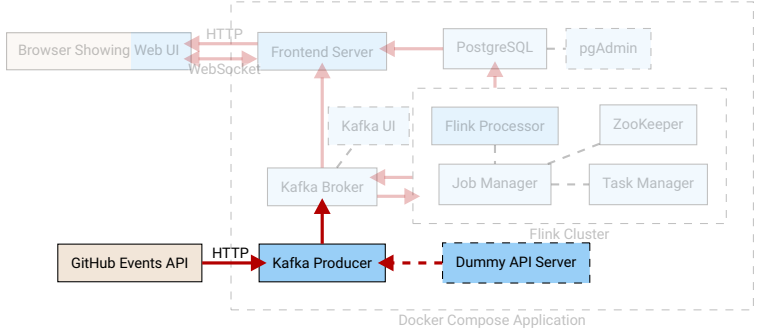
- Technology Stack:
  - → Backend: Java + Maven; RxJava; Apache Kafka; Apache Flink; PostgreSQL + TimescaleDB
  - → Frontend: Single Page Application with React + TypeScript; Vite; Recharts; RxJS
  - → Deployment: Docker and Docker Compose



System Architecture – Data Ingestion

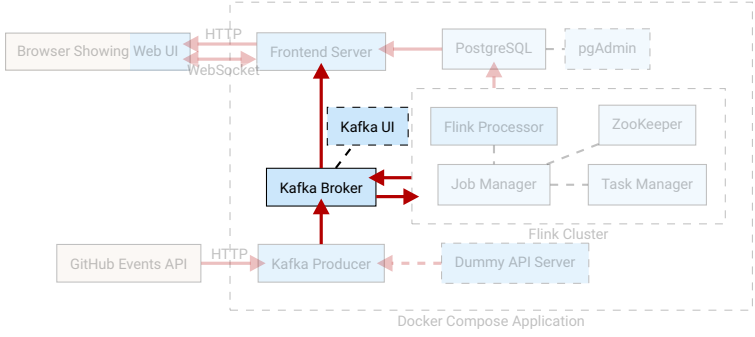
- Kafka Producer:
  - → Polls GitHub API periodically, respecting rate limits.
  - → Retrieves overlapping windows, then deduplicates events.
  - → Publishes deduplicated events to Kafka topic.

- Testing Mode:
  - → Dummy API server to simulate real GitHub API with configurable throughput.



System Architecture – Messaging

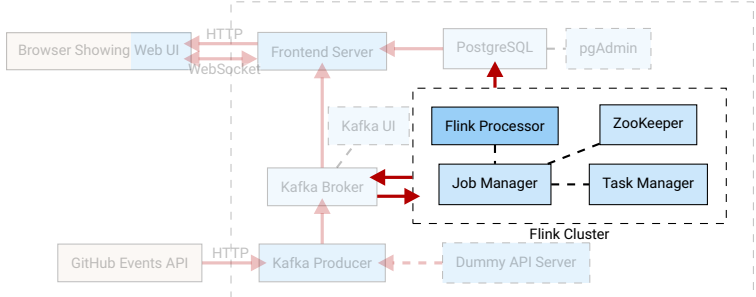
- Apache Kafka:
  - → Decouples the ingestion from the processing.
  - → Decouples the processing from the frontend.
  - → Kafka message retention enables restarting Flink job without losing events.



System Architecture – Stream Processing

- Core Processing Tasks:
  - → Retrieve raw events from Kafka an parse JSON.
  - → Event-time processing using Watermarks with 10s maximum out-of-orderness.
  - → Writes results to PostgreSQL and Kafka.

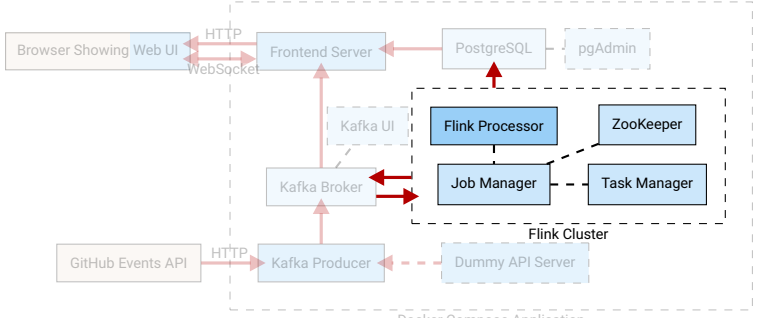
- Windowed Aggregations:
  - → Tumbling windows with 10s and 5min window sizes.
  - → Custom sliding windows with 5min, 1h, 6h, and 24h length, updated every second.



System Architecture – Stream Processing

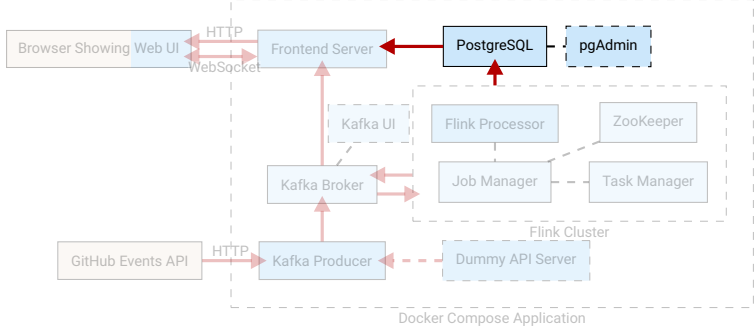
- Leaderboards:
  - → User and repository activity ranking.
  - → Based on latest values from sliding window aggregations.
  - → Optimization: Emits only changed rows and frontend reconstructs ranking.

- Trending Score:
  - → Weighted sum of recent stars: $t_{\text{score}} = 10s_{5\text{m}} + 5s_{5\text{h}} + 2s_{6\text{h}} + s_{24\text{h}}$.



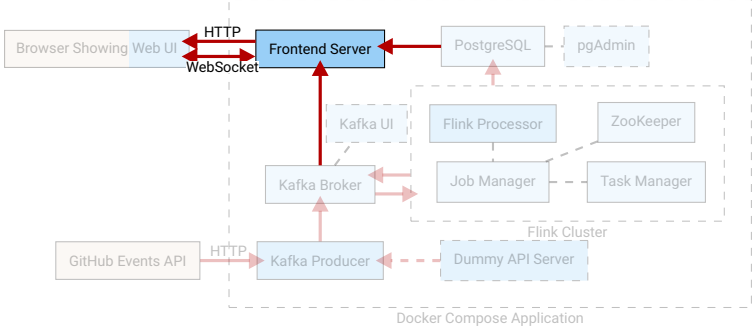
System Architecture – Storage

- PostgreSQL + TimescaleDB:
  - → Persistent storage for results of Flink processor.
  - → Handles queries for initial snapshot and historical data.
  - → Makes use of TimescaleDB hypertables and retention policy.
  - → Database commit before Kafka publish to ensure consistency.



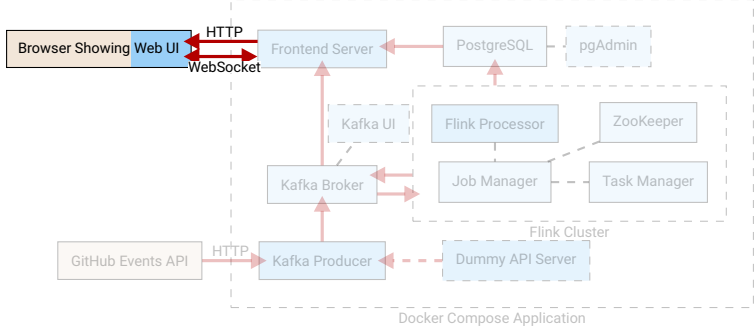
System Architecture – Data Serving

- Frontend Server:
  - → HTTP server for serving static files of the client web application.
  - → WebSocket server to serve API.
  - → Combines database queries for snapshots and Kafka streams for real-time updates.
  - → Manages client subscriptions to route events received from Kafka.



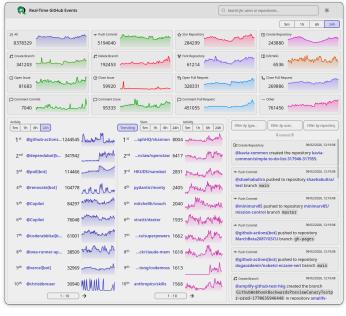
System Architecture – Frontend

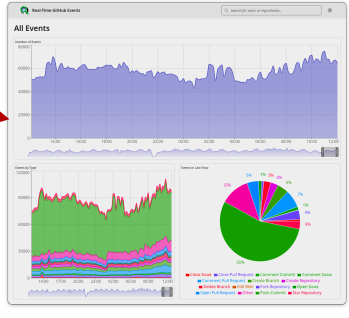
- Web Application:
  - → A filterable live event stream.
  - → WebSocket server to serve API.
  - → Real-time counters for event volumes.
  - → User and repository leaderboards.

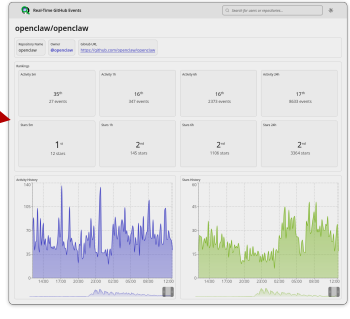


Functionalities and Demo

- Live Demo: `https://rtgh.rolandb.com`







Conclusion

- Successes:
  - → Robust architecture able to handle 70-120 events per second.
  - → Docker and Docker Compose simplifies deployment.
  - → Responsive UI with leaderboards and charts updated in real-time.

- Challenges:
  - → Real-time rankings and long sliding window efficiency.
  - → API changes made by GitHub reduced information.
  - → Debugging Flink operator logic and state management.

- Future Improvements:
  - → More advanced models to detect trending repositories.
  - → Social media integration to see where repositories or users are mentioned.
  - → Sentiment analysis on the text content of certain event types.