Firebase Backend Challenge: Event Ticketing System

Background

Design and implement core backend components of an event ticketing system using Firebase and related cloud services. The system should handle concurrent users, maintain data integrity, and process events in real-time.

Core Requirements

1. Data Modeling:
    - Design a database model for events, tickets, users, and purchases.
    - Optimize for efficient querying and scalability.
2. Ticket Purchasing Mechanism:
    - Implement a system that can handle concurrent users buying limited tickets.
    - Ensure data consistency and prevent overselling.
3. Real-time Inventory Management:
    - Design a system to manage ticket inventory in real-time.
    - Implement a mechanism to handle ticket releases and cancellations.
4. Asynchronous Task Processing:
    - Develop a solution for handling background tasks such as sending confirmation emails and updating analytics.
    - Implement a message queue for processing high-volume operations.

Coding Tasks

1. Create a function that handles ticket purchases:
    - Function should atomically update ticket availability and create a purchase record.
    - Implement concurrency control to prevent overselling.
    - Use appropriate database transactions to ensure data consistency.
2. Implement a trigger function for inventory updates:
    - Trigger should fire when ticket inventory changes.
    - Implement logic to update related documents or send notifications.
    - Ensure proper error handling and retry logic.
3. Develop a publisher and subscriber for event processing:
    - Publisher should send messages for events like ticket purchases or cancellations.
    - Subscriber should process these messages and update the database accordingly.
    - Implement proper error handling and ensure at-least-once delivery.

4. Create a script to simulate high concurrency ticket purchases:
    - Script should create multiple concurrent purchase attempts.
    - Log success rates and any consistency issues.
    - Use this script to test your system's ability to handle high load.

Deliverables

1. Brief system design document addressing the core requirements (1-2 pages)
2. Implementation of the coding tasks
3. Short explanation of your implementation choices and any assumptions made
4. List of potential improvements if you had more time

Your solution should demonstrate expert-level understanding of cloud-based backend development, focusing on scalability, real-time processing, unit tests, and clean code principles.

Note: Use any Firebase-compatible backend technologies you're comfortable with. The focus is on your problem-solving approach and implementation quality rather than specific technology choices.