

Bank Account Withdrawal - Implementation Overview

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Approach Outline

I implemented the solution in Python because it is my primary language. I used Kafka as the event-driven tool since I work with it regularly, and it can run locally. The core business functionality—handling withdrawals and event notifications—remains unchanged.

Key improvements:

- Modularized design
- Event-driven architecture with Kafka
- Transactional integrity using SQLAlchemy
- Logging for tracking transactions
- Kafka publishing with retries
- Portability with SQLite

Directory Structure

The project is structured to ensure clear separation of concerns:

```
bank-account-withdrawal/
├── src/
│   ├── config.py           # Configuration settings and logging
│   ├── controller.py       # Handles withdrawal logic
│   ├── events.py           # Defines withdrawal event structure
│   ├── main.py             # CLI interface for withdrawals
│   ├── models.py           # Database models with SQLAlchemy
│   ├── producer.py         # Kafka event producer with retries
│   ├── requirements.txt    # Dependencies for the project
│   ├── Makefile            # Commands to set up and run the project
│   └── activate_venv.sh    # Script to activate the virtual
└── environment
```

Implementation Choices

1. Database and Transaction Handling

- Used SQLAlchemy ORM for transactions.
- with_for_update() prevents race conditions.
- Rollback mechanism ensures consistency.

2. Event Notification System (Kafka)

- Kafka was chosen because it's the event-driven tool I work with.
- Runs locally, simplifying development.
- Uses exponential backoff and retries for reliability.

3. Logging

- Configured structured logging globally.
- Logs track transaction outcomes and Kafka publishing.

4. Code Structure

- Used Enums (WithdrawalStatus) for status tracking.
- Organized components into separate modules.

Library Usage

Library	Purpose
sqlalchemy	ORM for database transactions
kafka-python	Kafka producer for event notifications
pretty-table	Formats account balances for CLI display

Clarifications

- sqlalchemy.dialects.sqlite.insert: Inserts account data while ignoring duplicates (OR IGNORE).
- KafkaProducer.flush(): Ensures event delivery before continuing execution.

Testing

Test-1: Try withdrawing money from an account that does not exist

```
[jeshan@JESHEN-HP-ENVY] ~/mnt/c/workspace/sandbox-public/bank-account-withdrawal
$ make run-main
Running main...
PYTHONPATH=. venv/bin/python src/main.py
2025-05-17 19:41:49,726 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=bootstrap-0 host=localhost:9092 <connecting> [IPv4 ('127.0.0.1', 9092)]>: connecting to localhost:9092 [('127.0.0.1', 9092) IPv4]
2025-05-17 19:41:49,730 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=bootstrap-0 host=localhost:9092 <checking_api_versions_recv> [IPv4 ('127.0.0.1', 9092)]>: Broker version identified as 2.6
2025-05-17 19:41:49,731 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=bootstrap-0 host=localhost:9092 <connected> [IPv4 ('127.0.0.1', 9092)]>: Connection complete.
Database and table initialized successfully.

Available Accounts:
+-----+
| Account ID | Balance |
+-----+
| 1           | 461.00  |
| 2           | 996.00  |
| 3           | 159.00  |
| 4           | 952.00  |
| 5           | 849.00  |
+-----+

Enter Account ID to withdraw money from: 0
Enter amount to withdraw: 12
2025-05-17 19:41:57,638 - config - ERROR - Account 0 not found.
```

Status: PASS

Test-2: Try withdrawing an invalid amount from an existing account

```
[jeshan@JESHEN-HP-ENVY] ~/mnt/c/workspace/sandbox-public/bank-account-withdrawal
$ make run-main
Running main...
PYTHONPATH=. venv/bin/python src/main.py
2025-05-17 19:46:47,308 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=bootstrap-0 host=localhost:9092 <connecting> [IPv4 ('127.0.0.1', 9092)]>: connecting to localhost:9092 [('127.0.0.1', 9092) IPv4]
2025-05-17 19:46:47,325 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=bootstrap-0 host=localhost:9092 <checking_api_versions_recv> [IPv4 ('127.0.0.1', 9092)]>: Broker version identified as 2.6
2025-05-17 19:46:47,326 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=bootstrap-0 host=localhost:9092 <connected> [IPv4 ('127.0.0.1', 9092)]>: Connection complete.
Database and table initialized successfully.

Available Accounts:
+-----+
| Account ID | Balance |
+-----+
| 1           | 461.00  |
| 2           | 996.00  |
| 3           | 159.00  |
| 4           | 952.00  |
| 5           | 849.00  |
+-----+

Enter Account ID to withdraw money from: 1
Enter amount to withdraw: 0
2025-05-17 19:47:02,223 - config - WARNING - Invalid withdrawal amount.
```

Status: PASS

Test-3: Try withdrawing a large amount from an existing account

```
[jeshan@JESHEN-HP-ENVY] ~/mnt/c/workspace/sandbox-public/bank-account-withdrawal
$ make run-main
Running main...
PYTHONPATH=. venv/bin/python src/main.py
2025-05-17 19:50:03,260 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=bootstrap-0 host=localhost:9092 <connecting> [IPv4 ('127.0.0.1', 9092)]>: connecting to localhost:9092 [('127.0.0.1', 9092) IPv4]
2025-05-17 19:50:03,279 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=bootstrap-0 host=localhost:9092 <checking_api_versions_recv> [IPv4 ('127.0.0.1', 9092)]>: Broker version identified as 2.6
2025-05-17 19:50:03,280 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=bootstrap-0 host=localhost:9092 <connected> [IPv4 ('127.0.0.1', 9092)]>: Connection complete.
Database and table initialized successfully.

Available Accounts:
+-----+
| Account ID | Balance |
+-----+
| 1           | 461.00  |
| 2           | 996.00  |
| 3           | 159.00  |
| 4           | 952.00  |
| 5           | 849.00  |
+-----+

Enter Account ID to withdraw money from: 1
Enter amount to withdraw: 1000
2025-05-17 19:50:08,732 - config - WARNING - Insufficient funds for account 1.
```

Status: PASS

Test-4: Try withdrawing a valid amount from an existing account

```
└─$ jeshen@JESHER-HP-ENVY:~/mnt/c/workspace/sandbox-public/bank-account-withdrawal$
└─$ make run-main
Running main...
PYTHONPATH=. venv/bin/python src/main.py
2025-05-17 19:56:18,543 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=bootstrap-0 host=localhost:9092 <connecting> [IPv4 ('127.0.0.1', 9092)]>: connecting to localhost:9092 [IPv4 ('127.0.0.1', 9092)]
2025-05-17 19:56:18,546 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=bootstrap-0 host=localhost:9092 <checking_api_versions_recv> [IPv4 ('127.0.0.1', 9092)]>: Broker version identified as 2.6
2025-05-17 19:56:18,547 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=bootstrap-0 host=localhost:9092 <connected> [IPv4 ('127.0.0.1', 9092)]>: Connection complete.
Database and table initialized successfully.

Available Accounts:
+-----+
| Account ID | Balance |
+-----+
| 1           | 461.00  |
| 2           | 896.00  |
| 3           | 159.00  |
| 4           | 952.00  |
| 5           | 849.00  |
+-----+

Enter Account ID to withdraw money from: 2
Enter amount to withdraw: 100
2025-05-17 19:56:21,226 - config - INFO - Withdrawal successful for account 2, amount: 100.
2025-05-17 19:56:21,227 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=1002 host=localhost:9092 <connecting> [IPv4 ('127.0.0.1', 9092)]>: connecting to localhost:9092 [IPv4 ('127.0.0.1', 9092)]
2025-05-17 19:56:21,228 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=1002 host=localhost:9092 <connected> [IPv4 ('127.0.0.1', 9092)]>: Connection complete.
2025-05-17 19:56:21,230 - kafka.conn - INFO - <BrokerConnection client_id=kafka-python-producer-1, node_id=bootstrap-0 host=localhost:9092 <connected> [IPv4 ('127.0.0.1', 9092)]>: Closing connection.
2025-05-17 19:56:21,234 - config - INFO - Event published to Kafka.
Do you want to perform another withdrawal? (y/n): y

Available Accounts:
+-----+
| Account ID | Balance |
+-----+
| 1           | 461.00  |
| 2           | 796.00  |
| 3           | 159.00  |
| 4           | 952.00  |
| 5           | 849.00  |
+-----+
```

Status: PASS

- Bank Account Balance Updated
- Kafka Event Published