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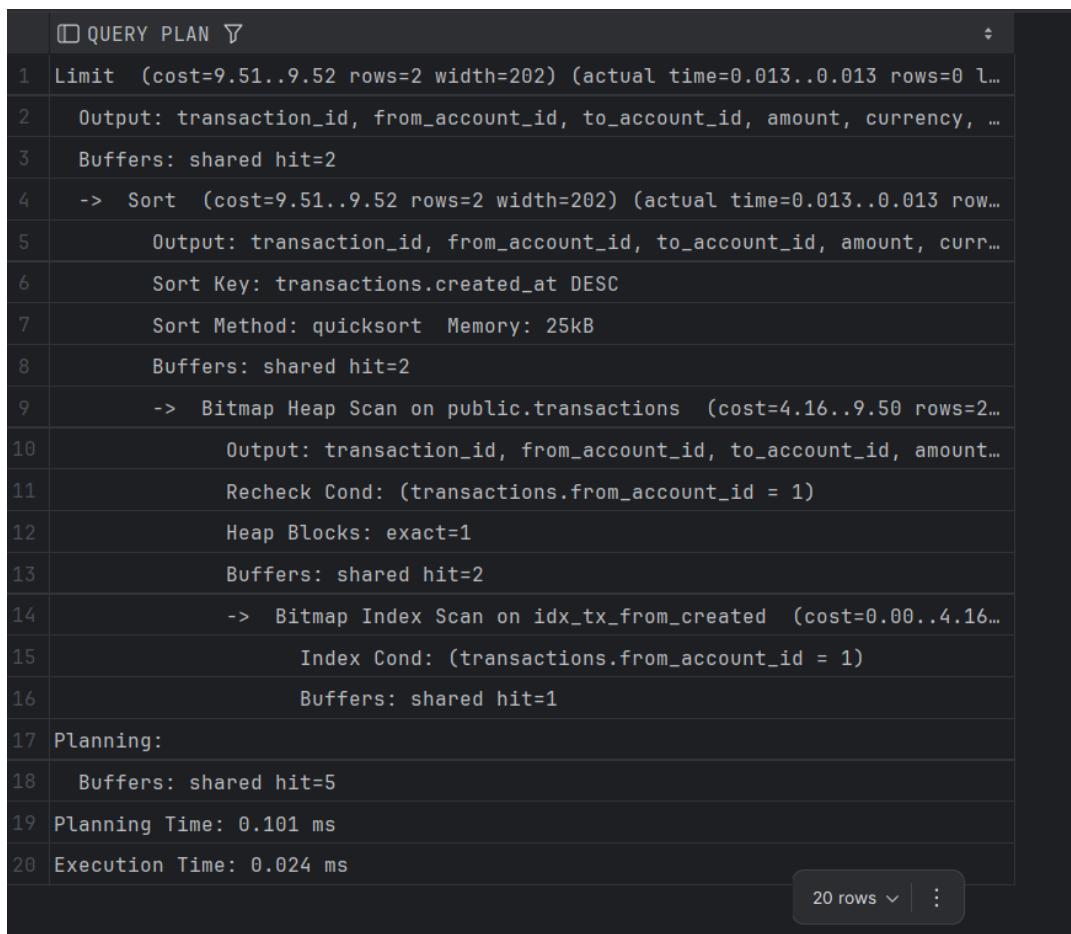
- Schema: customers, accounts, exchange\_rates, transactions, audit\_log
- Sample data ( $\geq 10$  customers/accounts/transactions/rates)
- Procedures: process\_transfer(...) and process\_salary\_batch(...)
- Reporting views: customer\_balance\_summary, daily\_transaction\_report, suspicious\_activity\_view (WITH security\_barrier)
- Indexes: B-tree, composite, hash, GIN (JSONB), partial, expression, covering index
- Materialized view: mv\_salary\_summary
- Test queries and EXPLAIN suggestions at file end

## Important notes

- process\_transfer uses SELECT ... FOR UPDATE, SAVEPOINT and logs failures/successes to audit\_log. It enforces sender status, sufficient balance, and daily limit (in KZT). Returns JSON with status and code.
- process\_salary\_batch uses pg\_advisory\_lock, stages payments in a temp table, uses per-item savepoints, applies updates atomically and bypasses daily limits (salary exception). Returns counts + failed details.
- Views convert balances to KZT using latest exchange\_rates. Ensure exchange\_rates contains needed direct X -> KZT rates for conversions.

## Test & grading artifacts to include

- Capture EXPLAIN (ANALYZE, BUFFERS) outputs for:
  - SELECT \* FROM accounts WHERE account\_number = '...';
  - SELECT \* FROM transactions WHERE from\_account\_id = 1 ORDER BY created\_at DESC LIMIT 50;



```
1  Limit  (cost=9.51..9.52 rows=2 width=202) (actual time=0.013..0.013 rows=0 l...
2    Output: transaction_id, from_account_id, to_account_id, amount, currency, ...
3    Buffers: shared hit=2
4    ->  Sort  (cost=9.51..9.52 rows=2 width=202) (actual time=0.013..0.013 row...
5      Output: transaction_id, from_account_id, to_account_id, amount, curr...
6      Sort Key: transactions.created_at DESC
7      Sort Method: quicksort  Memory: 25kB
8      Buffers: shared hit=2
9      ->  Bitmap Heap Scan on public.transactions  (cost=4.16..9.50 rows=2...
10        Output: transaction_id, from_account_id, to_account_id, amount...
11        Recheck Cond: (transactions.from_account_id = 1)
12        Heap Blocks: exact=1
13        Buffers: shared hit=2
14        ->  Bitmap Index Scan on idx_tx_from_created  (cost=0.00..4.16...
15          Index Cond: (transactions.from_account_id = 1)
16          Buffers: shared hit=1
17 Planning:
18   Buffers: shared hit=5
19 Planning Time: 0.101 ms
20 Execution Time: 0.024 ms
```

- Demonstrate concurrency:

- Session A: BEGIN; SELECT \* FROM accounts WHERE account\_number = '...' FOR UPDATE; (hold)
- Session B: run process\_transfer that touches same account (it will block until A commits/rolls back).

### **Limitations / assumptions**

- Exchange-rate fallback is basic; prefer direct p\_currency->KZT rates.
- Audit logging is inserted by procedures (no triggers).
- Sample data should be verified for typos (account ids / balances)
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