

ЛР 3. HA Postgres Cluster

Опираясь на гайд, мы подняли кластер Postgres

```
C:\Users\User1\Desktop\lab_1>docker compose up --build -d
[*] Building 2.0s (16/18)
-> [pg-master internal] load build definition from Dockerfile
-> => transferring dockerfile: 479B
-> [pg-slave internal] load build definition from Dockerfile
-> => transferring dockerfile: 479B
-> [pg-master internal] load metadata for docker.io/library/postgres:15
-> [pg-slave internal] load .dockerignore
-> => transferring context: 2B
-> [pg-master internal] load .dockerignore
-> => transferring context: 2B
-> [pg-slave 1/5] FROM docker.io/library/postgres:15@sha256:24d6c20ebba8c0440bceb24a8d4bf642f60bf7aea94887051ea5761d29c22323
-> => resolve docker.io/library/postgres:15@sha256:24d6c20ebba8c0440bceb24a8d4bf642f60bf7aea94887051ea5761d29c22323
-> [pg-slave internal] load build context
-> => transferring context: 68B
-> [pg-master internal] load build context
-> => transferring context: 68B
-> CACHED [pg-master 2/5] RUN apt-get update -y && apt-get install -y netcat-openbsd python3-pip curl python3-psycpg2 python3-venv iputils-ping
-> CACHED [pg-master 3/5] RUN python3 -m venv /opt/patroni-venv && /opt/patroni-venv/bin/pip install --upgrade pip && /opt/patroni-venv/bin/pip install patroni[zookeeper] psycpg2-binary
-> CACHED [pg-master 4/5] COPY postgres0.yml /postgres0.yml
-> CACHED [pg-slave 5/5] COPY postgres1.yml /postgres1.yml
-> [pg-master] exporting to image
-> => exporting layers
-> => exporting manifest sha256:84d39b5c3bb9deed13e80cd3293d5e8d401d8e9ded8c1e24c80e4a763b4fbaa7
-> => exporting config sha256:1e5f65287729f08e7e2d584c0f2a14b8b0c32c7e29e77cad4b4db466073df
-> => exporting attestation manifest sha256:692b0908eb9b9dae019fa23736a2d4f5402f2029fe06c7b45c4b598208dc06
-> => exporting manifest list sha256:3edeae0e2a0241bfb0d7d8bb1aeb44ff39aebc1e61b643f9b8d49f5eb940f
-> => naming to docker.io/library/lab_1-pg-master:latest
-> => unpacking to docker.io/library/lab_1-pg-master:latest
-> [pg-slave] exporting to image
-> => exporting layers
-> => exporting manifest sha256:a75cfa589ac03f7a00702a514fe02a7a92b3e529a00c96f8df1905ee0aawc4d
-> => exporting config sha256:60eebeb0c92b2a6f66c71fa1810e0e51f3d03d04f7f93e90c4150c074c90f982
-> => exporting attestation manifest sha256:F229fd1ae4ae4e5da2db4b2c5c8296c39a6ac4e593b16550e353428195c600a
-> => exporting manifest list sha256:33e9ddb5917b2c4f60e5f8e079c81b0f06ada0a9395d2ea199b422b4664ed88
-> => naming to docker.io/library/lab_1-pg-slave:latest
-> => unpacking to docker.io/library/lab_1-pg-slave:latest
-> [pg-master] resolving provenance for metadata file
-> [pg-slave] resolving provenance for metadata file
[+] Building 1.5s
Container zoo Started
Container pg-slave Started
Container pg-master Started
C:\Users\User1\Desktop\lab_1>docker compose logs -f
```

Ответы на вопросы:

При обычном перезапуске композ-проекта, будет ли сбилден заново образ?

Нет

А если предварительно отредактировать файлы postgresX.yml?

Нет

А если содержимое самого Dockerfile?

Нет

Почему?

Пока явно не попросить build или up --build, докер считает, что существующий образ годится

Проверяем репликацию:

Dashboard Properties SQL Statistics Dependencies Dependents postgres/postgres@db2*

postgres/postgres@db2

No limit

Query Query History

```
1 CREATE TABLE my_first_replication (  
2     id int,  
3     my_data varchar,  
4     my_comment varchar  
5 );  
6  
7 INSERT INTO my_first_replication VALUES('1',  
8     'my important data',  
9     'is this line replicated?')  
10
```

Data output Messages Notifications

INSERT 0 1

Query returned successfully in 56 msec.

Dashboard Properties SQL Statistics Dependencies Dependents postgres/postgres@db1*

postgres/postgres@db1

No limit

Query Query History

```
1 INSERT INTO my_first_replication VALUES('2',  
2     'bla bla bla',  
3     'work?')
```

Data output Messages Notifications

ERROR: cannot execute INSERT in a read-only transaction
SQL state: 25006



В pgAdmin мы подключились к нодам постгреса, в pg-master создали таблицу и записали туда данные, на последнем (На данный момент) скриншоте видно, что таблица появилась сразу в обоих нодах.

На третьем скрине видно, что при попытке записать данные в pg-slave, возникает ошибка

Высокая доступность:

Следуя гайду, добавили HAProxy и перезапустили проект

```
=> [pg-master] exporting to image
=> => exporting layers
=> => exporting manifest sha256:84d39b5c38b9deed13e80cd3293d5e8d401d8a9ded6c1e24c80a4a763b4fbba7
=> => exporting config sha256:1e5f652073729fc00cfa2d58c69f2e14b8bbbc32c7e29e77cad24b4db466073df
=> => exporting attestation manifest sha256:700df709b29e731f17c04578162819b9708c2192f76a658cdd789990e41ac00d
=> => exporting manifest list sha256:db37225db9302f36deffc0e6ee976fd05959d8c4f3b09a250d43b4d25c353c03
=> => naming to docker.io/library/lab_1-pg-master:latest
=> => unpacking to docker.io/library/lab_1-pg-master:latest
=> [pg-slave] exporting to image
=> => exporting layers
=> => exporting manifest sha256:a75cfa589ac03f7a00782a514fe82a7a92b3e529a90c96f8d6f1905ee0aeac4d
=> => exporting config sha256:60eb8c92b2a6f66c71fa1810e9e51f3df03d04f7f93e98c4150c074c90f982
=> => exporting attestation manifest sha256:15f9da51e4c977b4c4abbb3ed464bbba7256266928b8df95863efa373a15d86c
=> => exporting manifest list sha256:f18ef13a64ead4e262196e3af9852255354dbdcf2aace63aca64f6ea97f3cf0e
=> => naming to docker.io/library/lab_1-pg-slave:latest
=> => unpacking to docker.io/library/lab_1-pg-slave:latest
=> [pg-slave] resolving provenance for metadata file
=> [pg-master] resolving provenance for metadata file
+ Running 3/5
[+] Network lab_1_default          Created
[+] Container pg-master           Started
[+] Container zoo                  Started
[+] Container pg-slave            Started
[+] Container postgres_entrypoint Started

C:\Users\User1\Desktop\lab_1>
```

После отключения мастер ноды:

```
C:\Users\User1\Desktop\lab_1>docker stop pg-slave
pg-slave
C:\Users\User1\Desktop\lab_1>docker logs postgres_entrypoint
[NOTICE] (1) : New worker (0) forked
[NOTICE] (1) : Loading success.
[WARNING] (8) : Server postgres/pg_master is DOWN, reason: Layer4 connection problem, info: "Connection refused", check duration: 0ms. 1 active and 0 backup servers left. 0 sessions active, 0 requested, 0 remaining in queue.
[WARNING] (8) : Server postgres/pg_slave is DOWN, reason: Layer4 connection problem, info: "Connection refused", check duration: 0ms. 0 active and 0 backup servers left. 0 sessions active, 0 requested, 0 remaining in queue.
[ALERT] (8) : proxy 'postgres' has no server available!
[WARNING] (8) : Server postgres/pg_slave is UP, reason: Layer7 check passed, code: 200, check duration: 1ms. 1 active and 0 backup servers online. 0 sessions requested, 0 total in queue.
[WARNING] (8) : Server postgres/pg_master is UP, reason: Layer7 check passed, code: 200, check duration: 1ms. 2 active and 0 backup servers online. 0 sessions requested, 0 total in queue.
[WARNING] (8) : Server postgres/pg_slave is DOWN, reason: Layer4 timeout, check duration: 3002ms. 1 active and 0 backup servers left. 0 sessions active, 0 requested, 0 remaining in queue.

C:\Users\User1\Desktop\lab_1>docker logs
'docker logs' requires exactly 1 argument.
See 'docker logs --help'.

Usage: docker logs [OPTIONS] CONTAINER
Fetch the logs of a container
```



```
C:\Users\User1\Desktop\lab 1>docker logs pg-master
2025-12-07 23:28:29,123 INFO: Connecting to zoo(172.18.0.4):2181, use_ssl: False
2025-12-07 23:28:29,123 WARNING: Connection dropped: socket connection error: Connection refused
2025-12-07 23:28:29,253 INFO: Connecting to zoo(172.18.0.4):2181, use_ssl: False
2025-12-07 23:28:29,254 WARNING: Connection dropped: socket connection error: Connection refused
2025-12-07 23:28:29,442 INFO: Connecting to zoo(172.18.0.4):2181, use_ssl: False
2025-12-07 23:28:29,442 WARNING: Connection dropped: socket connection error: Connection refused
2025-12-07 23:28:29,888 INFO: Connecting to zoo(172.18.0.4):2181, use_ssl: False
2025-12-07 23:28:29,888 WARNING: Connection dropped: socket connection error: Connection refused
2025-12-07 23:28:31,106 INFO: Connecting to zoo(172.18.0.4):2181, use_ssl: False
2025-12-07 23:28:31,106 WARNING: Connection dropped: socket connection error: Connection refused
2025-12-07 23:28:32,029 INFO: Connecting to zoo(172.18.0.4):2181, use_ssl: False
2025-12-07 23:28:32,029 WARNING: Connection dropped: socket connection error: Connection refused
2025-12-07 23:28:33,330 INFO: Connecting to zoo(172.18.0.4):2181, use_ssl: False
2025-12-07 23:28:33,352 INFO: Zookeeper connection established, state: CONNECTED
2025-12-07 23:28:33,364 INFO: No PostgreSQL configuration items changed, nothing to reload.
2025-12-07 23:28:33,368 INFO: Systemd integration is not supported
2025-12-07 23:28:33,407 WARNING: Postgresql is not running.
2025-12-07 23:28:33,407 INFO: Lock owner: None; I am postgresql0
2025-12-07 23:28:33,409 INFO: pg_controldata:
    pg_control version number: 1300
    Catalog version number: 202209061
    Database system identifier: 7581248061605298199
    Database cluster state: shut down in recovery
    pg_control last modified: Sun Dec 7 23:28:13 2025
    Latest checkpoint location: 0/8000108
    Latest checkpoint's REDO location: 0/80000D0
    Latest checkpoint's REDO WAL file: 000000060000000000000000
    Latest checkpoint's TimeLineID: 6
    Latest checkpoint's PrevTimeLineID: 6
    Latest checkpoint's full_page_writes: on
    Latest checkpoint's NextXID: 0:744
    Latest checkpoint's NextOID: 16394
    Latest checkpoint's NextMultiXactId: 1
    Latest checkpoint's NextMultiOffset: 0
    Latest checkpoint's oldestXID: 717
    Latest checkpoint's oldestXID's DB: 1
    Latest checkpoint's oldestActiveXID: 744
    Latest checkpoint's oldestMultiXid: 1
    Latest checkpoint's oldestMulti's DB: 1
    Latest checkpoint's oldestCommitTsXid: 0
    Latest checkpoint's newestCommitTsXid: 0
    Time of latest checkpoint: Sun Dec 7 23:26:13 2025
    Fake LSN counter for unlogged rels: 0/3E8
    Minimum recovery ending location: 0/9000000
    Min recovery ending loc's timeline: 6
    Backup start location: 0/0
    Backup end location: 0/0
    End-of-backup record required: no
    wal_level setting: replica
    wal_log_hints setting: on
    max_connections setting: 100
```

```
max_worker_processes setting: 0
max_wal_senders setting: 10
max_prepared_xacts setting: 0
max_locks_per_xact setting: 64
track_commit_timestamp setting: off
Maximum data alignment: 8
Database block size: 8192
Blocks per segment of large relation: 131072
WAL block size: 8192
Bytes per WAL segment: 16777216
Maximum length of identifiers: 64
Maximum columns in an index: 32
Maximum size of a TOAST chunk: 1996
Size of a large-object chunk: 2048
Date/time type storage: 64-bit integers
Float8 argument passing: by value
Data page checksum version: 0
HACK authentication nonce: e090efbbcf57eb7912d5e150c25fae57c2dee9b277e34752571341c6096a503e

2025-12-07 23:28:33,434 INFO: Lock owner: None; I am postgresql0
2025-12-07 23:28:33,435 INFO: starting as a secondary
2025-12-07 23:28:33,756 UTC [24] LOG: starting PostgreSQL 15.15 (Debian 15.15-1.pgdg13+1) on x86_64-pc-linux-gnu, compiled by gcc (Debian 14.2.0-19) 14.2.0, 64-bit
2025-12-07 23:28:33,756 UTC [24] LOG: listening on IPv4 address '0.0.0.0', port 5432
2025-12-07 23:28:33,758 INFO: postmaster pid=24
2025-12-07 23:28:33,762 UTC [24] LOG: listening on Unix socket "/var/lib/postgresql/15/main/.s.PGSQL.5432"
2025-12-07 23:28:33,774 UTC [28] LOG: database system was shut down in recovery at 2025-12-07 23:28:13 UTC
2025-12-07 23:28:33,774 UTC [28] WARNING: specified neither primary_conninfo nor restore_command
2025-12-07 23:28:33,774 UTC [28] HINT: The database server will regularly poll the pg_wal subdirectory to check for files placed there.
2025-12-07 23:28:33,774 UTC [28] LOG: entering standby mode
2025-12-07 23:28:33,774 UTC [29] FATAL: the database system is starting up
localhost:5432 - rejecting connections
2025-12-07 23:28:33,780 UTC [31] FATAL: the database system is starting up
localhost:5432 - rejecting connections
2025-12-07 23:28:33,785 UTC [28] LOG: redo starts at 0/6000000
2025-12-07 23:28:33,785 UTC [28] LOG: invalid magic number 0000 in log segment 000000060000000000000000, offset 0
2025-12-07 23:28:33,785 UTC [28] LOG: consistent recovery state reached at 0/9000000
2025-12-07 23:28:33,785 UTC [28] LOG: invalid magic number 0000 in log segment 000000060000000000000000, offset 0
2025-12-07 23:28:33,785 UTC [28] LOG: waiting for WAL to become available at 0/90000010
2025-12-07 23:28:33,785 UTC [24] LOG: database system is ready to accept read-only connections
localhost:5432 - accepting connections
2025-12-07 23:28:34,813 INFO: establishing a new patroni heartbeat connection to postgres
2025-12-07 23:28:34,817 INFO: establishing a new patroni restapi connection to postgres
2025-12-07 23:28:34,850 INFO: Got response from postgresql http://pg-slave-888/patroni: {"state": "running", "postmaster_start_time": "2025-12-07 23:28:33.778094+00:00", "role": "replica", "server_version": 150015, "xlog": [{"received_location": "150095104", "replayed_location": "150095104", "replayed_timestamp": null, "paused": false, "timeline": 6, "cluster_unlocked": true, "dcs_last_seen": 1765150114, "database_system_identifier": "7581248061605298199", "patroni": [{"version": "4.1.0", "scope": "psql_cluster", "name": "postgresql"}]}
2025-12-07 23:28:34,852 INFO: Wal position of postgresql is ahead of my wal position
2025-12-07 23:28:34,866 INFO: local timeline=6 lsn=0/9000000
server signaled
2025-12-07 23:28:34,875 UTC [24] LOG: received SIGHUP, reloading configuration files
2025-12-07 23:28:34,875 UTC [24] LOG: parameter 'primary_conninfo' changed to 'dbname=postgres user=replicator password=/tmp/pgpass0 host=pg-slave-pot-5432 sslmode=prefer application_name=postgresql0 gssencmode=prefer channel_binding=pref'
2025-12-07 23:28:34,875 UTC [24] LOG: parameter 'primary_slot_name' changed to 'postgresql0'
2025-12-07 23:28:34,887 INFO: following a different leader because i am not the healthiest node
2025-12-07 23:28:34,887 INFO: started streaming WAL from primary at 0/9000000 on timeline 6
2025-12-07 23:28:34,978 UTC [46] LOG: replication terminated by primary server
2025-12-07 23:28:34,978 UTC [46] DETAIL: End of WAL reached on timeline 6 at 0/900000AB.
2025-12-07 23:28:34,978 UTC [46] LOG: ending timeline history file for timeline 7 from primary server
2025-12-07 23:28:34,993 UTC [28] LOG: new target timeline is 7
2025-12-07 23:28:34,993 UTC [28] LOG: invalid record length at 0/900000AB: wanted 24, got 0
2025-12-07 23:28:34,993 UTC [46] LOG: restarted WAL streaming at 0/90000010 on timeline 7
2025-12-07 23:28:44,815 INFO: lock owner: postgresql1; I am postgresql0
2025-12-07 23:28:44,819 INFO: local timeline=7 lsn=0/90001AB
2025-12-07 23:28:44,819 INFO: primary timeline=7
```

```

2025-12-07 23:28:44,849 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:28:44,850 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:29:14,814 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:29:14,814 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:29:14,816 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:29:44,815 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:29:44,815 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:30:14,815 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:30:14,816 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:30:44,814 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:30:44,815 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:31:14,815 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:31:14,817 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:31:44,816 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:31:44,816 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:32:14,814 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:32:14,817 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:32:44,813 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:32:44,814 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:33:14,813 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:33:14,812 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:33:14,812 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:33:13,940 UTC [26] LOG: restartpoint starting: time
2025-12-07 23:33:13,940 UTC [26] LOG: restartpoint complete: wrote 2 buffers (0.0%); 0 WAL file(s) added, 0 removed, 0 recycled; write=0.012 s, sync=0.002 s, total=0.034 s; sync files=1, longest=0.002 s, average=0.002 s; distance=16384 B; estimate=16384
2025-12-07 23:33:13,940 UTC [26] LOG: recovery restart point at 0/9000000
2025-12-07 23:33:13,940 UTC [26] DETAIL: last completed transaction was at log time 2025-12-07 23:28:36.021365+00.
2025-12-07 23:33:14,815 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:33:44,816 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:33:44,818 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:34:14,814 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:34:14,814 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:34:24,816 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:34:24,817 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:34:44,815 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:34:44,815 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:35:14,814 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:35:14,815 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:35:44,813 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:35:44,814 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:36:14,814 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:36:14,815 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:36:44,813 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:36:44,813 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:37:14,813 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:37:14,815 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:37:44,813 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:37:44,813 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:38:14,812 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)
2025-12-07 23:38:14,812 INFO: no action. I am (postgres@10), a secondary, and following a leader (postgres@11)

```

После падения pg-slave Patroni автоматически выполнил failover: pg-master был промотирован в нового лидера и начал обслуживать запросы как мастер

После остановки pg-slave HAProxy начинает фиксировать таймауты к нему, она перестаёт использовать упавший pg-slave и оставляет в пуле только pg-master (уже как нового мастера). Поэтому все дальнейшие клиентские запросы через entrypoint идут на живой сервер

Мы попытались сделать запись в бд через entrypoint подключение:

Dashboard
Properties
SQL
Statistics
Dependencies
Dependents
postgres/postgres@proxy*

postgres/postgres@proxy

No limit

Query
Query History

1
INSERT INTO failover_test VALUES (2);

Data output
Messages
Notifications

INSERT 0 1

Query returned successfully in 6 secs 305 msec.

Total rows: 1 of 1
Query complete 00:00:06.305

У нас получилось, но HAProxy ещё какое-то время пытался опрашивать мёртвый pg-slave и ждал таймаут перед тем, как переключиться на живой сервер