

Neon - cloud-native storage backend for PostgreSQL

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What is Neon?

- Startup
 - founded March 2021
- New storage system for PostgreSQL
 - Open source
- Cloud service
 - psql -h pg.neon.tech
 - In beta, invite code "pgconfeu"



What is Neon?

- Storage and compute are separated
- Single writer, multiple readers
- Multi-tenant storage
- Single-tenant compute
 - runs in Kubernetes containers / VMs
- Cheap copy-on-write branching and timetravel query



Traditional setup





Traditional setup in the cloud





Traditional setup in the cloud





Neon architecture



Storage and Compute are separated

Compute = PostgreSQL

- no persistent data
- runs in a container or VM
- starts up in 4 seconds

Storage = Neon storage system

- shared







Why?

- Compute can be completely shut down, and started quickly
 - No restore from backup
 - No WAL recovery
 - Serverless!
- Same storage can be shared by multiple read-only nodes
- Scale independently
- Cloud storage is cheap



Storage and Compute are separated

PostgreSQL:

- streams WAL to the safekeepers
- reads pages from pageservers
- write() is a no-op
- local disk only for temporary files, sorting etc







Best platform to run PostgreSQL

We try to minimize changes to PostgreSQL:

- No changes to planner or executor
- Support all extensions, tools
- Support all PostgreSQL index types
- PostgreSQL handles MVCC

Replace low-level storage, close to where read() & write() happens

- Goal is to get all changes into PostgreSQL



What did you need to change in PostgreSQL?

Most code is in an extension. Core changes include:

- Make smgr API extendable
- Startup without crash recovery
- WAL-log command ID
- Track last-written LSN
- Cache relation sizes
- Prefetching sequential scans

https://github.com/neondatabase/neon/blob/main/docs/core_changes.md

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| src/backend/access/transam/xloginert.c 377 ***********************************

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| Str.Dackendy/storage/strespecture 1

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| 56 files changed 1372 insertions(+) 233 deletions(-)

 | 56 f | iles ch | anged | 1372 inco | rtions(+) | 233 deleti | ons(-) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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Write path

PostgreSQL streams the WAL to the safekeepers

- Three running safekeepers
- Consensus algorithm based on Paxos
- Ensures durability of recent transactions
- WAL is stored on local SSDs





Write path: Pageservers

- Digests the PostgreSQL WAL
- Re-orders and processes it into immutable files
- Uploads files to cloud storage
- Local SSDs for caching





Durability

- Recent transactions (= recent WAL) are made durable in safekeepers
- Older WAL is uploaded to cloud storage, in processed format
- Pageservers are disposable





Read path: Pageservers

GetPage(Rel id, Block #, LSN)

- Replays WAL to reconstruct pages, *on demand*
- Can reconstruct any page at any point in time





Control plane and proxy

- Control plane starts and stops compute nodes
- Provide web user interface and _ user-facing API for creating databases, branches etc.
- Proxy to accept and authenticate user connections



plane



Branching

- Want to try how an index would affect query plans?
- Want to run a long-running query?
- Want to have a fresh copy of your production database for testing?

Create a branch! They are copy-on-write and cheap



Branching

Branching replaces backups, WAL archive and Point-in-time Restore

- Instead of a backup schedule, configure *retention period*

Within the retention period, you can:

- Create a branch
- Timetravel
- Bisect, when was this row updated?



Traditional Point-In-Time Recovery

- Take daily backup
- and archive the WAL

To restore:

- Restore last backup before the point-in-time
- Replay all the log

W A L		time
W A L	'	
W A L	'	Database Backup
W A L	'	
W A L		Database Backup



Neon does this at *page granularity*

WAL contains a mix of:

- full page images of pages, and
- incremental WAL records.

To reconstruct a page version:

- Find the last image of the page, and
- Replay all the WAL records on top of it

To make this *perform*:

- Reorder and index the WAL
- Materialize and store additional page images



Current status

- Mostly works
- We are learning how to operate a cloud service
- Focused on performance, autoscaling
- Just rebased over PostgreSQL v15



Thank you!

Q & A

https://github.com/neondatabase/neon/

Try it: psql -h pg.neon.tech Invite code: pgconfeu

Feedback: heikki@neon.tech

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