ANTS AASMA

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CYBERTEC
POSTGRESQL SERVICES & SUPPORT

Hello

About me

What this talk is about

Why do we replicate?

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- Storage devices are hardware.
- We want our data to still be there after the failure.
- RAID is a form of replication, but with a single point of failure.

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- Consistency: “If I ask a replica”
- Durability: “After there is a failure”

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- Some failures you really can’t ignore.
- In some cases, restoring from backup is acceptable.
- Or you classify it as a “does not happen” problem:

English > National

G-Drive Fire Destroys 125,000 Officials' Data

No Backup Available for Government Cloud System, Recovery Uncertain

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    - For some value of “can’t”
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- Response times get longer.
- May need much more concurrency to get same throughput.

But how does it work?

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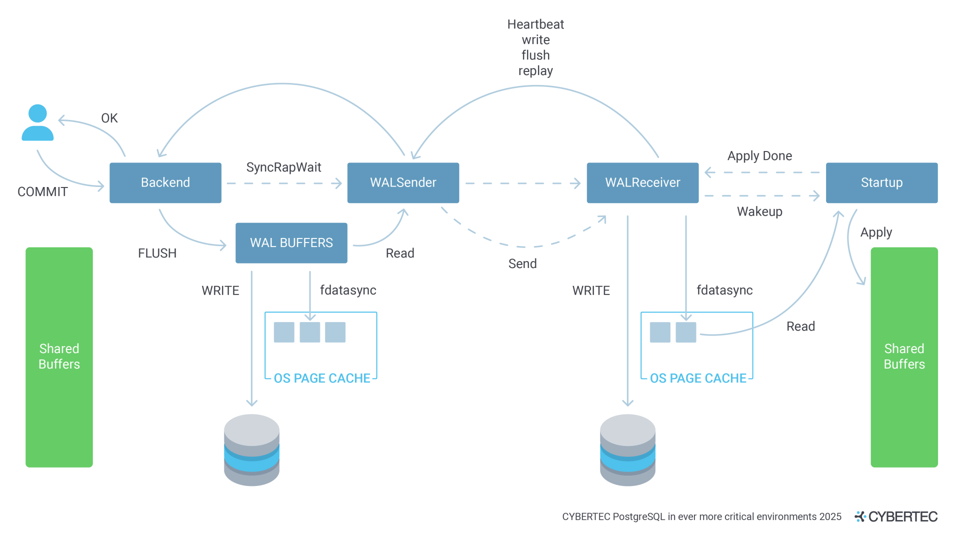
- PostgreSQL logs all data changes into WAL.
  - Writing changes to one place is easier than doing it in dozen places.
- Order of the changes encodes dependencies.
  - Logical - can't allow withdraw if deposit didn't happen.
  - Physical - index pointers should not go into empty space.

Lifecycle of a commit



How long the happy path takes

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  - Local NVMe: 15 µs - 250 µs average
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- Flush WAL to disk:
  - Local NVMe: 15 μs - 250 μs average
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- Send data over network
  - Typical datacenter network: 100 - 500 μs
  - Same city: + couple hundred μs
  - Longer distance + 5 ms / 1’000 km

The very happy path

Assumptions: 50μs disk latency, 200μs ping, 20μs processing.

1. Flush to local disk: 50 μs
2. Walsender wakes up, reads block, it gets sent immediately: 20μs
3. Data traverses the network: 100μs
4. Packet arrives at replica, walreceiver wakes, writes to disk, flushes and sends feedback: + 70 μs
5. Feedback traverses the network: 100 μs
6. Walsender wakes up, processes feedback, wakes up backend: 20μs

Total: 360μs (vs 50μs local)

The cloud path

Assumptions: 500μs disk latency, 500μs ping (cross-AZ), 20μs processing.

1. Flush to local disk: 500 μs
2. Walsender wakes up, reads block, it gets sent immediately: 20μs
3. Data traverses the network: 250μs
4. Packet arrives at replica, walreceiver wakes, writes to disk, flushes and sends feedback: + 520 μs
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Total: 1’560 μs (vs 500μs local)

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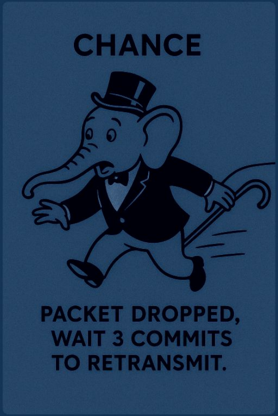
- Surely nobody notices if something takes a couple milliseconds more?
- Highly contended workloads care (a.k.a. Admdahl's law):
  - If every commit waits for 5ms we can only manage 200 updates per second.
- Connection pools care.
  - Every millisecond extra latency means 1 more connection needed per 1'000 tps.

Hazards await



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- Storage fabric switches DoS themselves: +60s
- Standby dies: . . .

Different levels of syncing

- synchronous_commit has levels
  - off - hopes and prayers mode
  - local - can survive a crash
  - remote_write - can survive a failover
  - on - can survive a crash and failover
  - remote_apply - read after write consistency

Head of line blocking

- If one commit is blocked, then all commits after it are also blocked.
- Replica that is busy syncing to disk can't confirm transactions.

Consistency issues

- You can cancel a wait for the commit.
- Commit will become visible immediately.
- But commit is not durable.
- Might be gone after failover.
- Have to be careful with retry loop.

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- pg_wait_sampling to get high resolution.
- `strace -p` or `perf record -p $walreceiver -e 'syscalls:sys_*'`
  - github.com/cybertec-postgresql/perf-analysis to find outliers.

perf-analysis

```
$ perf-analysis.py syscalls-*.script.zst \
  --include=fdatasync,pwrite64,epoll_wait,fsync \
  --stat --base=10
latency [ms] pwrite64 fdatasync epoll_wait fsync
       0.000                             1     3
       0.001    12213                  179    34
       0.010     9114
       0.100       19                  148
       1.000        2     11529        132    74
      10.000                 16          1    37
```

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  - Needs at least 2 replicas.

Quorum commit

- With 2 replicas it is unlikely that both have problem simultaneously.
- `synchronuos_standby_names = 'ANY 1 (node2, node3, node4)'`
- Primary still needs to flush before replication can begin.
  - PostgreSQL could improve on this.

Picking the right replica

- If the primary fails then `quorum` other nodes have the latest commit.
- Need to reach `num_replicas` - `quorum` + 1 nodes to be sure to see at least one of them.
- Look at `pg_last_wal_receive_lsn()` and `pg_last_wal_replay_lsn()`
- Or use Patroni `synchronous_mode: quorum`

Summary

- Figure out if you can afford to lose transactions.
- If you have to use it, know that every performance issue is amplified.
- Be prepared to use more connections.
- Add replicas to hide bad latencies.
- Automatically managing quorum commit is hard, use existing tools.

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