What's Missing in Postgres?

BRUCE MOMJIAN

The presentation explains why some features are missing in Postgres. *Title concept from Melanie Plageman*

https://momjian.us/presentations

Last updated: January 2026

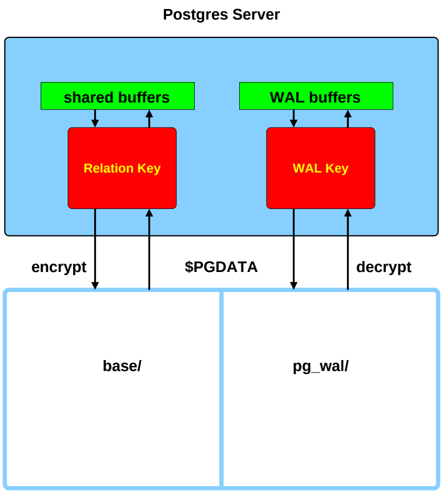
Outline

1. Postgres Feature History Since 2010

```
 version  |   reldate   | months | changes | C lines | C changes | % C change
----------+------------+--------+---------+---------+-----------+------------
 9.0      | 2010-09-20 |        |     237 |  870790 |           |
 9.1      | 2011-09-12 |     12 |     203 |  932936 |     62146 |          7
 9.2      | 2012-09-10 |     12 |     238 |  987460 |     54524 |          5
 9.3      | 2013-09-09 |     12 |     177 | 1040813 |     53353 |          5
 9.4      | 2014-12-18 |     15 |     211 | 1096707 |     55894 |          5
 9.5      | 2016-01-07 |     13 |     193 | 1167110 |     70403 |          6
 9.6      | 2016-09-29 |      9 |     214 | 1219720 |     52610 |          4
 10       | 2017-10-05 |     12 |     189 | 1316447 |     96727 |          7
 11       | 2018-10-18 |     12 |     170 | 1369590 |     53143 |          4
 12       | 2019-10-03 |     11 |     180 | 1423215 |     53625 |          3
 13       | 2020-09-24 |     12 |     178 | 1473738 |     50523 |          3
 14       | 2021-09-30 |     12 |     220 | 1558178 |     84440 |          5
 15       | 2022-10-13 |     12 |     184 | 1587763 |     29585 |          1
 16       | 2023-09-14 |     11 |     206 | 1608031 |     20268 |          1
 17       | 2024-09-26 |     12 |     182 | 1673116 |     65085 |          4
 18       | 2025-09-25 |     12 |     210 | 1750814 |     77698 |          4
 Averages |            |     12 |     200 |         |           |       4.27
```

https://momjian.us/main/blogs/pgblog/2021.html#April_28_2021

2. Cluster file encryption, i.e., TDE



https://momjian.us/main/presentations/pending.html#cfe

Cluster File Encryption

Advantages

- Meets regulatory requirements, e.g., PCI
- Does not require coordination with infrastructure teams for file system encryption
- Automatically encrypts file system backups

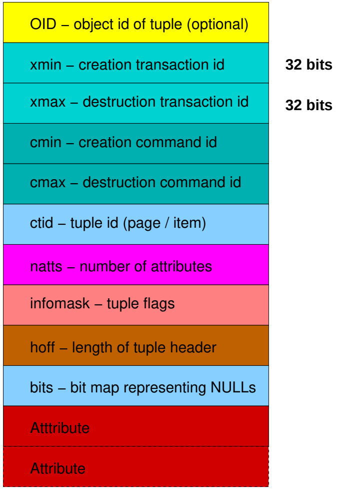
Disadvantages

- Of questionable security value, e.g. the key is in operating system memory
- Requires significant source code changes
- Client-side encryption is more secure

Percona is working on an open source TDE extension.

https://momjian.us/main/blogs/pgblog/2025.html#February_22_2025
https://docs.percona.com/pg-tde/

3.1 64-Bit Transaction Ids


OID – object id of tuple (optional)
xmin – creation transaction id
32 bits
xmax – destruction transaction id
32 bits
cmin – creation command id
cmax – destruction command id
ctid – tuple id (page / item)
natts – number of attributes
infomask – tuple flags
hoff – length of tuple header
bits – bit map representing NULLs
Atttribute
Attribute

https://momjian.us/main/presentations/internals.html#mvcc

64-Bit Transaction Ids

Advantages

- Avoids the need to freeze tuples

Disadvantages

- Could increase tuple header size by 33%
- Requires significant source code changes

3.2 Optimizer Hints

```
 l | count |                           lookup_letter
---+-------+-----------------------------------------------------------------------
 p |   342 | Seq Scan on sample  (cost=0.00..21.12 rows=342 width=2)
 c |    13 | Bitmap Heap Scan on sample  (cost=4.25..20.69 rows=13 width=2)
 r |    12 | Bitmap Heap Scan on sample  (cost=4.24..20.14 rows=12 width=2)
 f |     6 | Bitmap Heap Scan on sample  (cost=4.19..17.25 rows=6 width=2)
 t |     6 | Bitmap Heap Scan on sample  (cost=4.19..17.25 rows=6 width=2)
 s |     6 | Bitmap Heap Scan on sample  (cost=4.19..17.25 rows=6 width=2)
 u |     5 | Bitmap Heap Scan on sample  (cost=4.19..15.86 rows=5 width=2)
 _ |     5 | Bitmap Heap Scan on sample  (cost=4.19..15.86 rows=5 width=2)
 d |     4 | Bitmap Heap Scan on sample  (cost=4.18..14.23 rows=4 width=2)
 v |     4 | Bitmap Heap Scan on sample  (cost=4.18..14.23 rows=4 width=2)
 a |     3 | Bitmap Heap Scan on sample  (cost=4.17..12.31 rows=3 width=2)
 e |     2 | Bitmap Heap Scan on sample  (cost=4.16..10.07 rows=2 width=2)
 k |     1 | Index Only Scan using i_sample on sample  (cost=0.15..8.17 rows=1 width=2)
 i |     1 | Index Only Scan using i_sample on sample  (cost=0.15..8.17 rows=1 width=2)
```

https://momjian.us/main/presentations/performance.html#optimizer

Optimizer Hints

Advantages

- Useful for quick fixes of optimizer mistakes

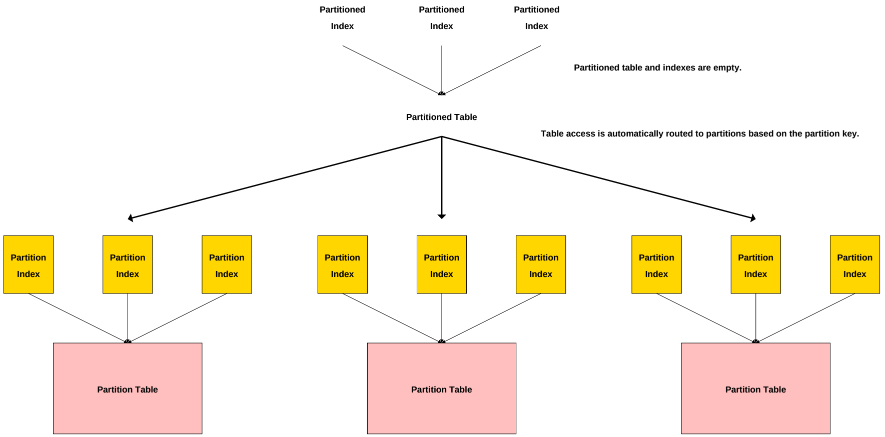
Disadvantages

- Locks query plans, preventing data distribution changes and optimizer improvements from using better plans
- While this can fix specific queries, the cause is often imperfect optimizer statistics or server settings
    - a more general fix can improve an entire class of queries, e.g., extended statistics, random_pages_cost
- Often prevents the problem from being diagnosed and reported to the database project

pg_hint_plan is already available as an open source extension.

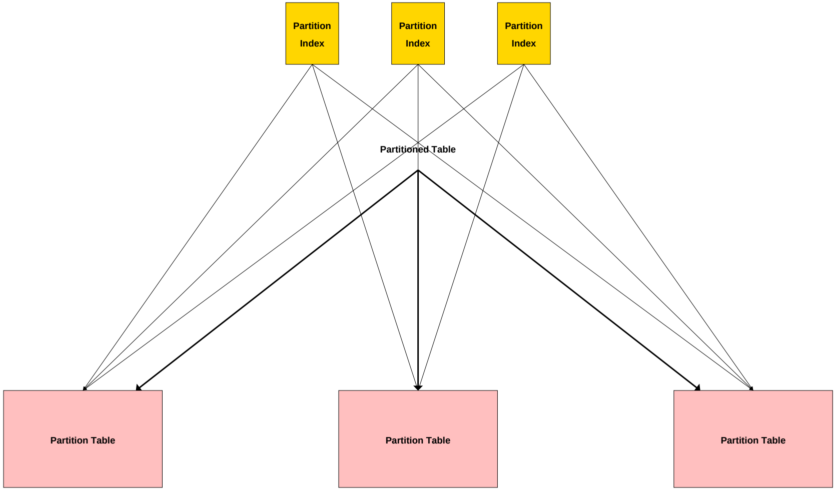
https://momjian.us/main/blogs/pgblog/2018.html#December_12_2018
https://github.com/ossc-db/pg_hint_plan

3.3 Global Indexes: Per-Partition Indexes



https://momjian.us/main/presentations/performance.html#partitioning

Global indexes



https://momjian.us/main/presentations/performance.html#partitioning

Global Indexes

Advantages

- Allows indexing of values that are not part of the partition key
- Allows unique constraints that are not part of the partition key

Disadvantages

- Partitioning is used to split very large tables, so global indexes would be very large
- Dropping partitions is expensive
- Requires significant source code changes

https://momjian.us/main/blogs/pgblog/2020.html#July_1_2020

3.4 Columnar Storage

Column 1

Value 1	Row 2, 7, 9, 12
Value 2	Row 1, 5, 11, 14
Value 3	Row 4, 6, 8, 15
Value 4	Row 3, 10, 13, 16

Column 2

Value 1	Row 4, 6, 11, 16
Value 2	Row 3, 10, 12, 14
Value 3	Row 1, 5, 7, 9
Value 4	Row 2, 8, 13, 15

Column 3

Value 1	Row 4, 7, 11, 14
Value 2	Row 2, 5, 6, 13
Value 3	Row 3, 8, 10, 12
Value 4	Row 1, 9, 15, 16

Columnar Storage

Advantages

- Column values are only stored once per table, reducing storage requirements
- Ideal for columns with many duplicates

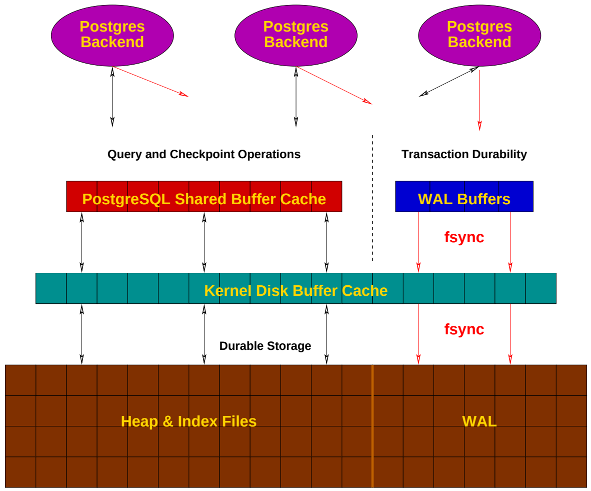
Disadvantages

- Accessing all columns of a row is expensive
- Updates and deletes are expensive
- Requires optimizer and storage changes

Citus is already available as an open source extension.

https://wiki.postgresql.org/wiki/ColumnOrientedSTorage
https://www.citusdata.com/product/community

3.5 Direct I/O



https://momjian.us/main/presentations/administration.html#wal

Direct I/O

Advantages

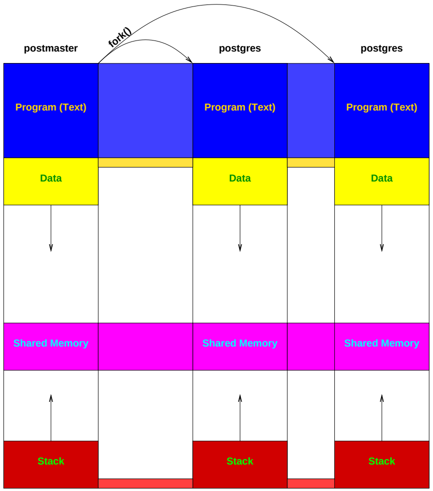
- Prevents double-buffering by the kernel and Postgres shared buffer cache
- Prevents copying of data from kernel buffers to shared buffers

Disadvantages

- Postgres-scheduled reads and writes might conflict with non-Postgres I/O
- Prevents sharing of kernel memory for I/O caching and per-process memory usage

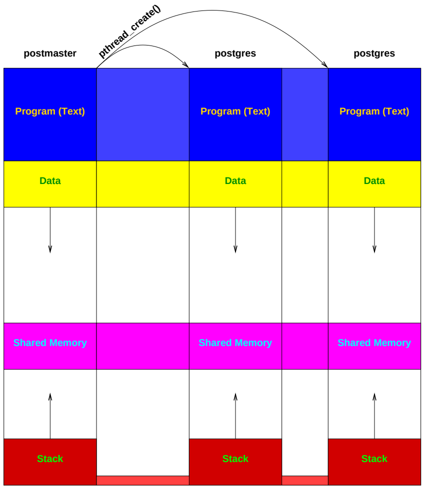
https://momjian.us/main/blogs/pgblog/2017.html#June_5_2017
https://momjian.us/main/blogs/pgblog/2018.html#December_7_2018

3.6 Server-Side Threading: Fork()



https://momjian.us/main/presentations/internals.html#shared_memory

Server-Side Threading



Server-Side Threading

Advantages

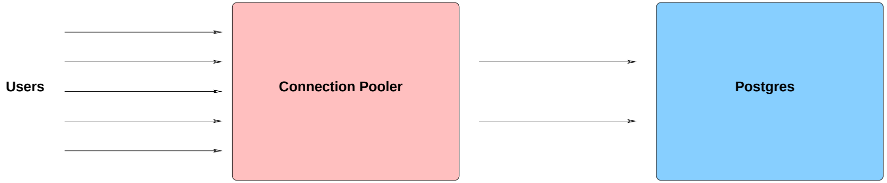
- Reduces task switching time

Disadvantages

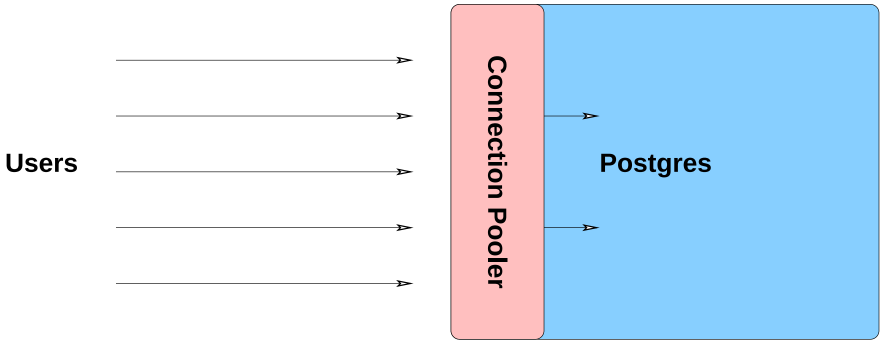
- Makes Postgres sessions less resilient to session failure
- Requires significant source code changes

https://momjian.us/main/blogs/pgblog/2018.html#December_26_2018

3.7 Internal Connection Pooler: External Pooler



Internal Connection Pooler



Internal Connection Pooler

Advantages

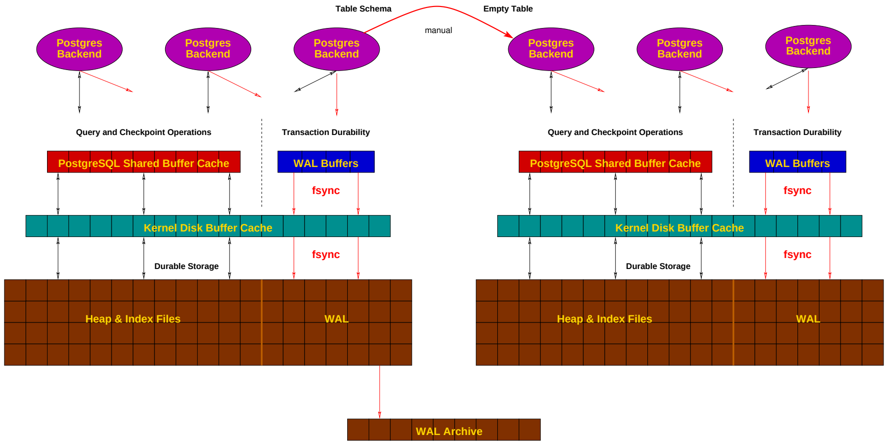
- Reduces latency
- More flexible authentication
- Simpler configuration

Disadvantages

- Insufficient for failover control

https://momjian.us/main/blogs/pgblog/2017.html#April_21_2017
https://momjian.us/main/blogs/pgblog/2019.html#January_25_2019

4.1 Logical Replication of DDL



https://momjian.us/main/presentations/administration.html#wal

Logical Replication of DDL

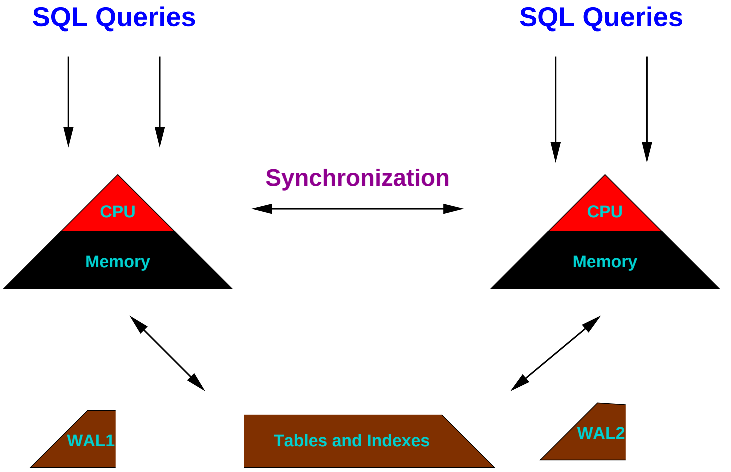
Advantages

- Simplifies administration

Disadvantages

- Requires regular source code updates to replicate new DDL

4.2 Oracle RAC-Like



https://momjian.us/main/presentations/performance.html#scaling

Oracle RAC-Like

Advantages

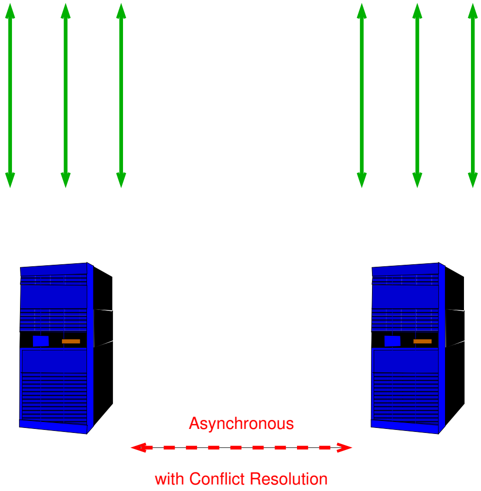
- Scales CPU and memory
- partial reliability, partial scaling

Disadvantages

- Does not scale I/O
- Communication overhead between hosts requires application workload partitioning
- Complex architecture

https://momjian.us/main/blogs/pgblog/2018.html#July_9_2018

4.3 Multi-Master Replication



https://momjian.us/main/presentations/arch.html#replication

Multi-Master Replication

Advantages

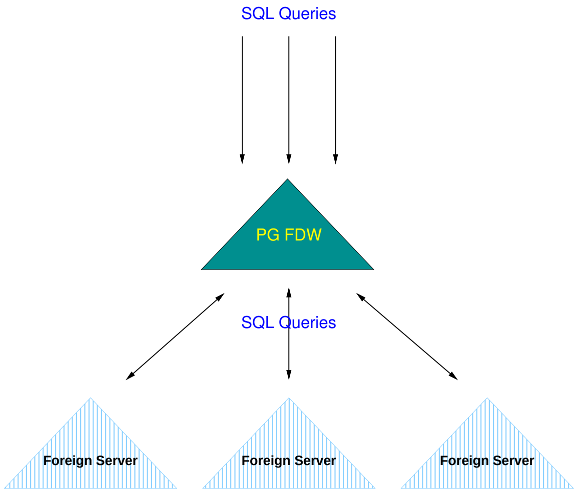
- Allows simple draining of server traffic for maintenance
- Allows read-only scaling without traffic management

Disadvantages

- Requires conflict resolution management
- Requires DDL management when using Postgres logical replication; see section 4a

https://momjian.us/main/blogs/pgblog/2018.html#July_9_2018

4.4 Sharding



https://momjian.us/main/presentations/pending.html#sharding

Sharding

Advantages

- Allows writes to be scaled across multiple servers
- Allows data volumes to exceed a single server

Disadvantages

- Complex setup and administration
- Additional latency
- Limited value for queries that are counter to the sharding key

https://momjian.us/main/blogs/pgblog/2023.html#November_1_2023
https://wiki.postgresql.org/wiki/Built-in_Sharding

5. Current Status

1. Postgres feature history
2. Cluster file encryption, i.e., TDE
3. Single host, performance
   - 3.1 64-bit transaction ids
   - 3.2 optimizer hints
   - 3.3 global indexes
   - 3.4 columnar storage
   - 3.5 direct I/O
   - 3.6 server-side threading
   - 3.7 internal connection pooler
4. Multi-host
   - 4.1 logical replication of DDL
   - 4.2 Oracle RAC-like
   - 4.3 multi-master replication
   - 4.4 sharding
5. Current status

Green is in-progress; red is no progress

Conclusion

https://momjian.us/presentations

https://www.flickr.com/photos/bryanh/