The Best of Bruce's Postgres Slides

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EDB

This talk has the best slides from my 25+ Postgres presentations.

https://momjian.us/presentations

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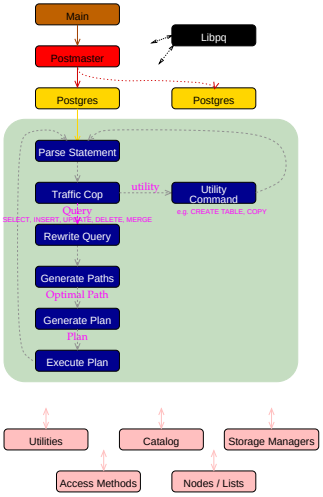
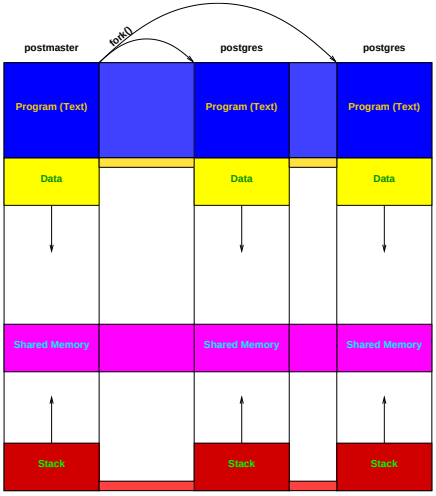
Postgres System Architecture

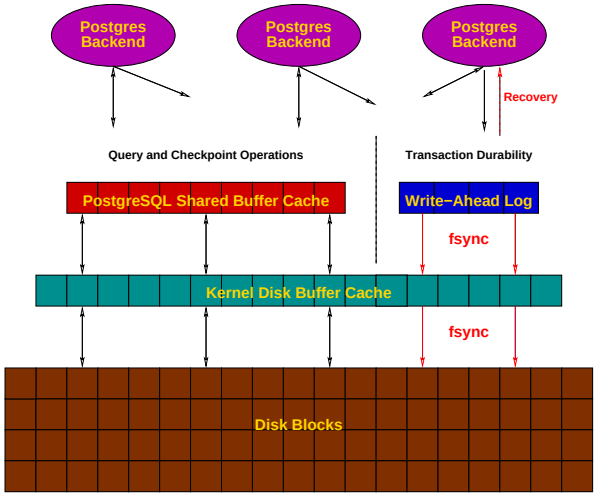


Shared Memory Creation

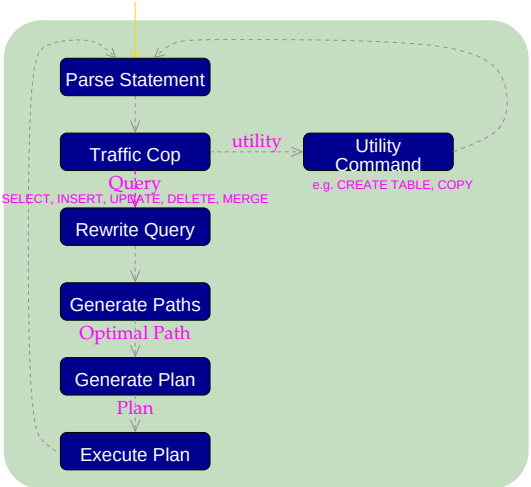


Inside PostgreSQL Shared Memory

Shared Buffers and WAL



Backend Flowchart — Magnified



Query Processing

```
FindExec: found "/var/local/postgres/./bin/postmaster" using argv[0]
./bin/postmaster: BackendStartup: pid 3320 user postgres db test socket 5
./bin/postmaster child[3320]: starting with (postgres -d99 -F -d99 -v131072 -p test )
FindExec: found "/var/local/postgres/./bin/postgres" using argv[0]
DEBUG:  connection: host=[local] user=postgres database=test
DEBUG:  InitPostgres
DEBUG:  StartTransactionCommand
DEBUG:  query: SELECT firstname
                FROM friend
                WHERE age = 33;
DEBUG:  parse tree: { QUERY :command 1  :utility <> :resultRelation 0 :into <> :isPortal false :isBinary false :isTemp false :hasAgg
s false :hasSubLinks false :rtable ({ RTE :relname friend :relid 26912  :subquery <> :alias <> :eref { ATTR :relname friend :attrs (
 "firstname"  "lastname"  "city"  "state"  "age" )} :inh true :inFromCl true :checkForRead true :checkForWrite false :checkAsUse
r 0}) :jointree { FROMEXPR :fromlist ({ RANGETBLREF 1 }) :quals { EXPR :typeOid 16  :opType op :oper { OPER :opno 96 :opid 0 :opresu
lttype 16 } :args ({ VAR :varno 1 :varattno 5 :vartype 23 :vartypmod -1  :varlevelsup 0 :varnoold 1 :varoattno 5} { CONST :consttype
 23 :constlen 4 :constbyval true :constisnull false :constvalue  4 [ 33 0 0 0 ] })}) :rowMarks () :targetList ({ TARGETENTRY :resdom
 { RESDOM :resno 1 :restype 1042 :restypmod 19 :resname firstname :reskey 0 :reskeyop 0 :ressortgroupref 0 :resjunk false } :expr {
VAR :varno 1 :varattno 1 :vartype 1042 :vartypmod 19  :varlevelsup 0 :varnoold 1 :varoattno 1})} :groupClause <> :havingQual <> :dis
tinctClause <> :sortClause <> :limitOffset <> :limitCount <> :setOperations <> :resultRelations <>}
DEBUG:  rewritten parse tree:
DEBUG:  { QUERY :command 1  :utility <> :resultRelation 0 :into <> :isPortal false :isBinary false :isTemp false :hasAggs false :has
SubLinks false :rtable ({ RTE :relname friend :relid 26912  :subquery <> :alias <> :eref { ATTR :relname friend :attrs ( "firstname"
   "lastname"  "city"  "state"  "age" )} :inh true :inFromCl true :checkForRead true :checkForWrite false :checkAsUser 0}) :joint
ree { FROMEXPR :fromlist ({ RANGETBLREF 1 }) :quals { EXPR :typeOid 16  :opType op :oper { OPER :opno 96 :opid 0 :opresulttype 16 }
:args ({ VAR :varno 1 :varattno 5 :vartype 23 :vartypmod -1  :varlevelsup 0 :varnoold 1 :varoattno 5} { CONST :consttype 23 :constle
n 4 :constbyval true :constisnull false :constvalue  4 [ 33 0 0 0 ] })}) :rowMarks () :targetList ({ TARGETENTRY :resdom { RESDOM :r
esno 1 :restype 1042 :restypmod 19 :resname firstname :reskey 0 :reskeyop 0 :ressortgroupref 0 :resjunk false } :expr { VAR :varno 1
 :varattno 1 :vartype 1042 :vartypmod 19  :varlevelsup 0 :varnoold 1 :varoattno 1})} :groupClause <> :havingQual <> :distinctClause
<> :sortClause <> :limitOffset <> :limitCount <> :setOperations <> :resultRelations <>}
DEBUG:  plan: { SEQSCAN :startup_cost 0.00 :total_cost 22.50 :rows 10 :width 12 :qptargetlist ({ TARGETENTRY :resdom { RESDOM :resno
 1 :restype 1042 :restypmod 19 :resname firstname :reskey 0 :reskeyop 0 :ressortgroupref 0 :resjunk false } :expr { VAR :varno 1 :va
rattno 1 :vartype 1042 :vartypmod 19  :varlevelsup 0 :varnoold 1 :varoattno 1})} :qpqual ({ EXPR :typeOid 16  :opType op :oper { OPE
R :opno 96 :opid 65 :opresulttype 16 } :args ({ VAR :varno 1 :varattno 5 :vartype 23 :vartypmod -1  :varlevelsup 0 :varnoold 1 :varo
attno 5} { CONST :consttype 23 :constlen 4 :constbyval true :constisnull false :constvalue  4 [ 33 0 0 0 ] })}) :lefttree <> :rightt
ree <> :extprm () :locprm () :initplan <> :nprm 0  :scanrelid 1 }
DEBUG:  ProcessQuery
DEBUG:  CommitTransactionCommand
DEBUG:  proc_exit(0)
DEBUG:  shmem_exit(0)
DEBUG:  exit(0)
./bin/postmaster: reaping dead processes...
./bin/postmaster: CleanupProc: pid 3320 exited with status 0
```

EXPLAIN with Constants of Various Frequencies

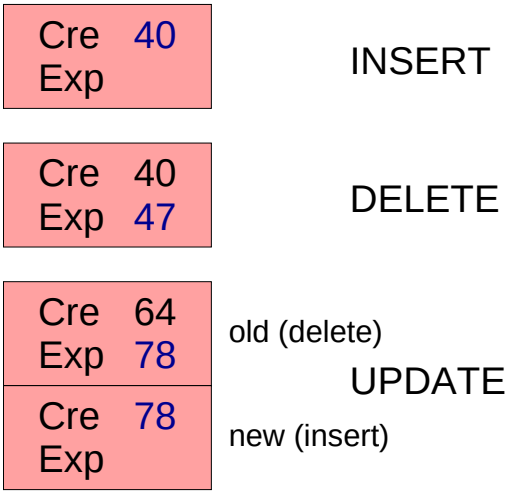
l	count	lookup_letter
p	199	Seq Scan on sample (cost=0.00..13.16 rows=199 width=2)
s	9	Seq Scan on sample (cost=0.00..13.16 rows=9 width=2)
c	8	Seq Scan on sample (cost=0.00..13.16 rows=8 width=2)
r	7	Seq Scan on sample (cost=0.00..13.16 rows=7 width=2)
t	5	Bitmap Heap Scan on sample (cost=4.29..12.76 rows=5 width=2)
f	4	Bitmap Heap Scan on sample (cost=4.28..12.74 rows=4 width=2)
v	4	Bitmap Heap Scan on sample (cost=4.28..12.74 rows=4 width=2)
d	4	Bitmap Heap Scan on sample (cost=4.28..12.74 rows=4 width=2)
a	3	Bitmap Heap Scan on sample (cost=4.27..11.38 rows=3 width=2)
_	3	Bitmap Heap Scan on sample (cost=4.27..11.38 rows=3 width=2)
u	3	Bitmap Heap Scan on sample (cost=4.27..11.38 rows=3 width=2)
e	2	Index Scan using i_sample on sample (cost=0.00..8.27 rows=1 width=2)
i	1	Index Scan using i_sample on sample (cost=0.00..8.27 rows=1 width=2)
k	1	Index Scan using i_sample on sample (cost=0.00..8.27 rows=1 width=2)

Deadlocks

```
SELECT pg_sleep(0.500); SELECT * FROM lockview1;
  pid  | vxid  |   lock_type   |     lock_mode     | granted | xid_lock |  relname
-------+-------+---------------+-------------------+---------+----------+------------
 11306 | 2/61  | transactionid | ExclusiveLock     | t       | 710      |
 11306 | 2/61  | relation      | RowExclusiveLock  | t       |          | i_lockdemo
 11306 | 2/61  | relation      | RowExclusiveLock  | t       |          | lockdemo
 11306 | 2/61  | tuple         | ExclusiveLock     | t       |          | lockdemo
 11306 | 2/61  | transactionid | ShareLock         | f       | 711      |
 11642 | 3/116 | transactionid | ExclusiveLock     | t       | 711      |
 11642 | 3/116 | relation      | RowExclusiveLock  | t       |          | i_lockdemo
 11642 | 3/116 | relation      | RowExclusiveLock  | t       |          | lockdemo
 11642 | 3/116 | tuple         | ExclusiveLock     | t       |          | lockdemo
 11642 | 3/116 | transactionid | ShareLock         | f       | 710      |
```

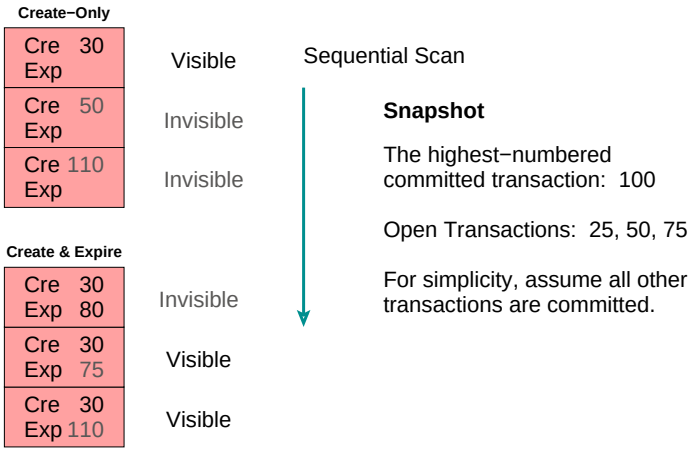
Unlocking the Postgres Lock Manager

MVCC Behavior



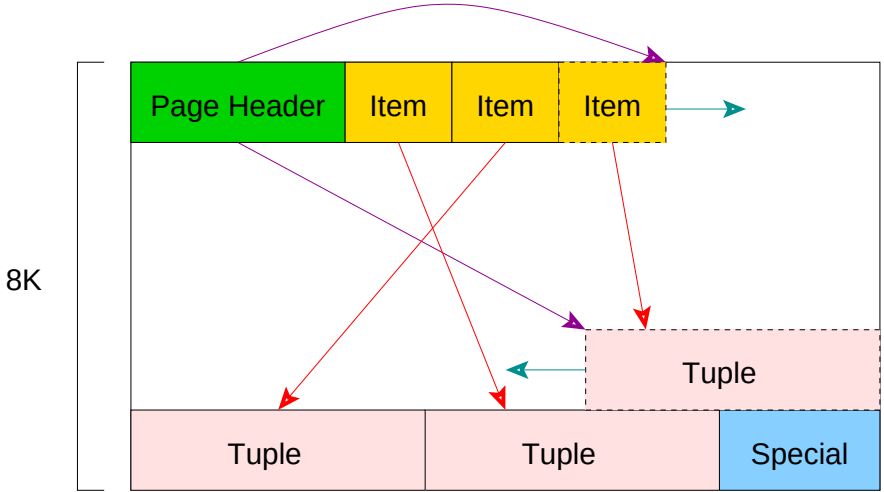
UPDATE is effectively a DELETE and an INSERT.

MVCC Examples

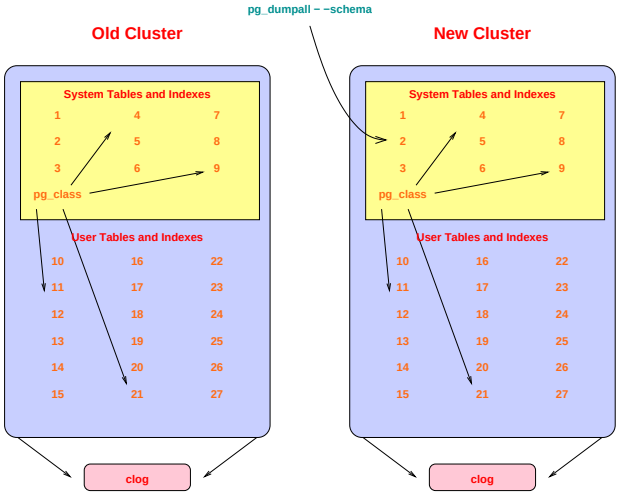


Internally, the creation xid is stored in the system column 'xmin', and expire in 'xmax'.

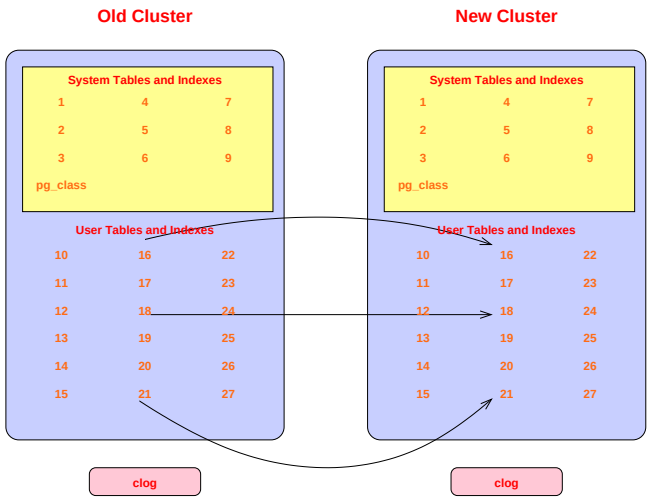
Heap Page Structure



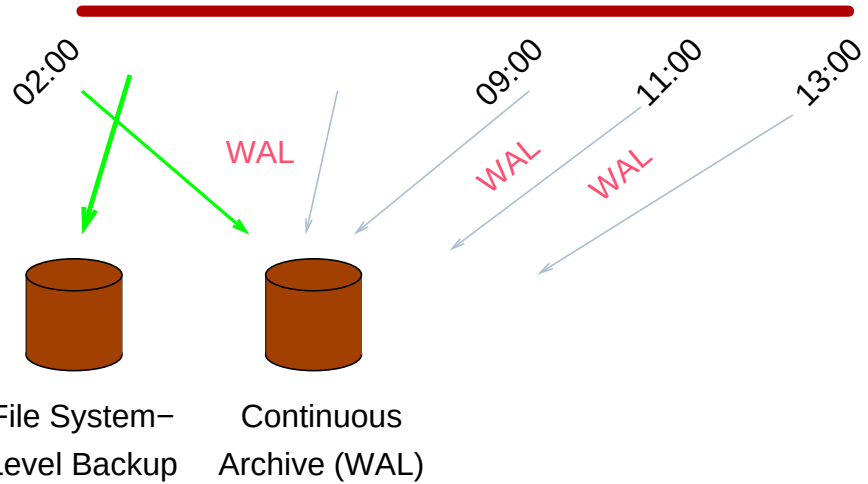
Pg_upgrade: Restore Schema In New Cluster



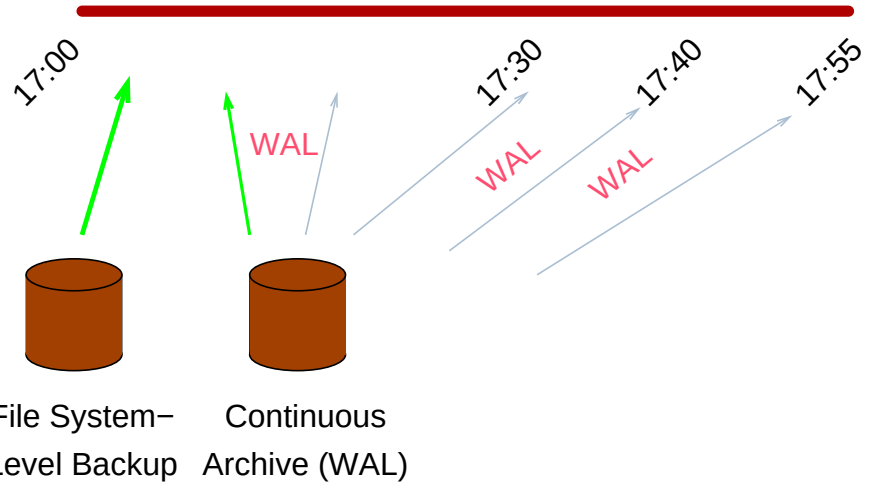
Pg_upgrade: Copy User Heap/Index Files



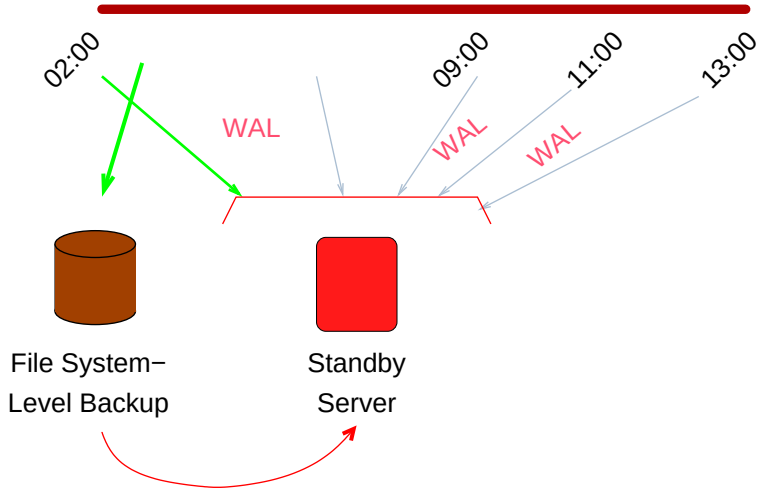
Continuous Archiving



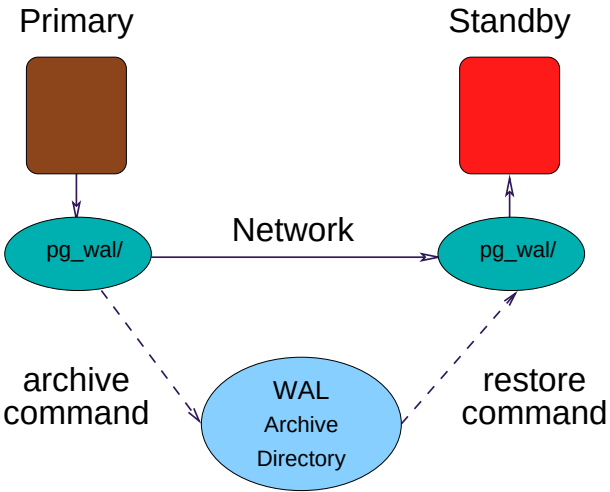
Point-in-Time Recovery



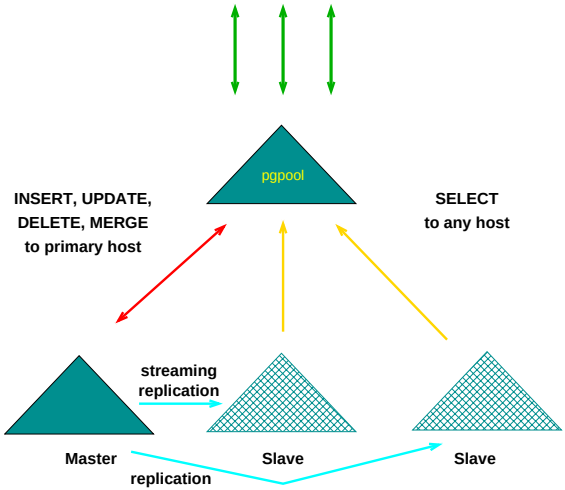
Streaming Replication Setup



Streaming Replication in Operation

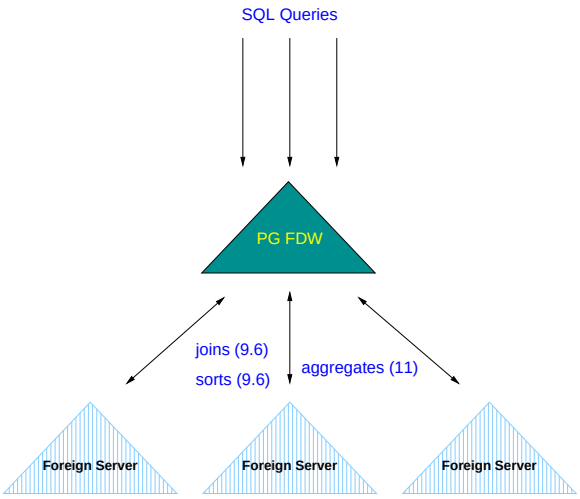


Read Scaling Using Pgpool & Streaming Replication

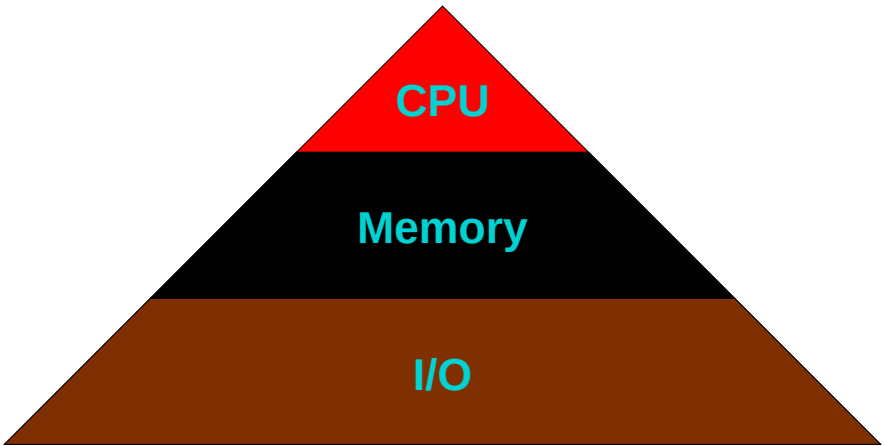


A full copy of the data exists on every node.

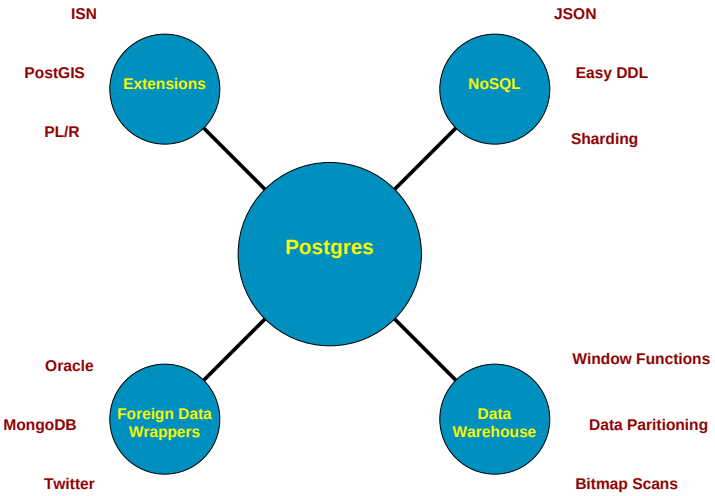
Write Scaling Using FDW-Based Sharding



Database Server Hardware Priorities



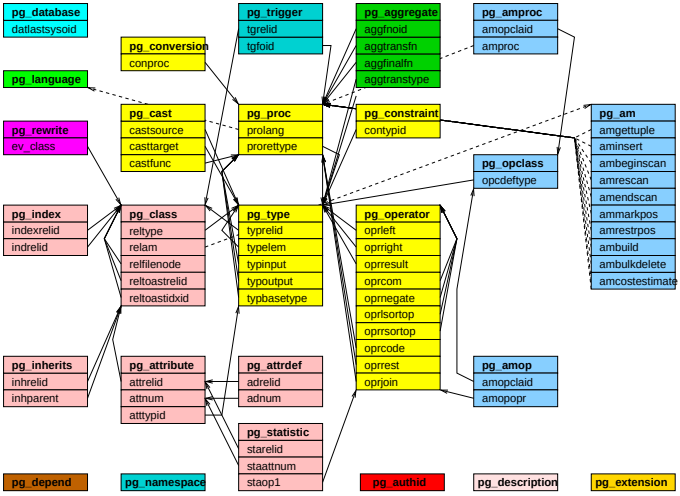
Postgres's Central Role



Use of the Contains Operator @>

```
\do @>
                                    List of operators
   Schema   | Name | Left arg type | Right arg type | Result type | Description
------------+------+---------------+----------------+-------------+-------------
 pg_catalog | @>   | aclitem[]     | aclitem        | boolean     | contains
 pg_catalog | @>   | anyarray      | anyarray       | boolean     | contains
 pg_catalog | @>   | anyrange      | anyelement     | boolean     | contains
 pg_catalog | @>   | anyrange      | anyrange       | boolean     | contains
 pg_catalog | @>   | box           | box            | boolean     | contains
 pg_catalog | @>   | box           | point          | boolean     | contains
 pg_catalog | @>   | circle        | circle         | boolean     | contains
 pg_catalog | @>   | circle        | point          | boolean     | contains
 pg_catalog | @>   | jsonb         | jsonb          | boolean     | contains
 pg_catalog | @>   | path          | point          | boolean     | contains
 pg_catalog | @>   | polygon       | point          | boolean     | contains
 pg_catalog | @>   | polygon       | polygon        | boolean     | contains
 pg_catalog | @>   | tsquery       | tsquery        | boolean     | contains
```

Postgres System Tables



PostgreSQL Internals Through Pictures

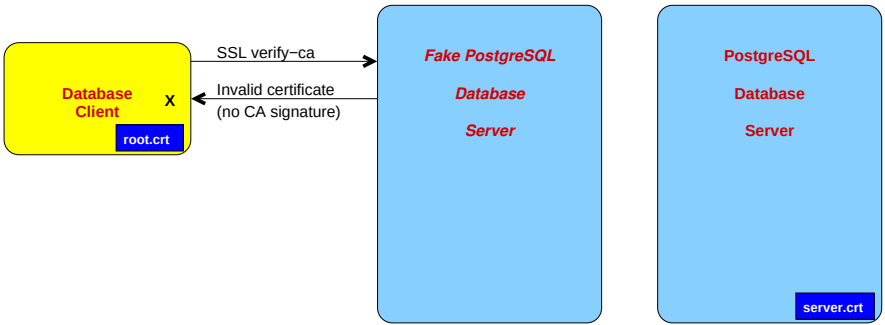
CTEs: Mixing Modification Commands

```
CREATE TEMPORARY TABLE old_orders (order_id INTEGER);

WITH source (order_id) AS (
        DELETE FROM orders WHERE name = 'my order' RETURNING order_id
), source2 AS (
        DELETE FROM items USING source WHERE source.order_id = items.order_id
)
INSERT INTO old_orders SELECT order_id FROM source;
```

Programming the SQL Way with Common Table Expressions

SSL 'Verify-Ca' Is Secure From Spoofing



Conclusion

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