Database Design Best Practices -

(Understanding common mistakes)

Jobin Augustine

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1.

Poor Selection of Data types

- Common mistake when migrating Other database systems to PostgreSQL
- **40%** performance penalty is common.
- Space wastage
- Costly Indexes.

Data Type Best Practice.

- **PostgreSQL has 40+ main data types**
- **Use of NUMERIC instead of INTEGER or BIGINT is the common mistake**
- **Select data types based on:**
  - Takes the least amount of space and complexity to hold the data
  - Avoid runtime data type conversions in.
  - Look for built in functionality (example inet,macaddr)

2.

Unused Indexes

- **Indexes are created based on assumptions or carried over from other database systems**
- **Never monitored or assessed**
- **PostgreSQL tables are heap structures. Cheap to scan. Index scans are not always better.**
- **Underestimates the impact of unused Indexes**
  - Each Transaction slows down
  - Write amplification.
  - More WAL is generated
  - Occupies shared buffers / cache
  - Impact on the Autovacuum.

3.

PostgreSQL Defaults

- **The defaults are set to get a minimal functional system in a smallest possible hardware.**
- **Tuning is mandatory**
- **Tuning must consider**
  - Available hardware resources (CPU & Memory)
  - Type of workload. OLTP vs OLAP
  - Connections
  - Storage.

4.

Poor Defaults by DBaaS

- DBaaS solutions are found to set very odd values
- Assumption of Cloud providers gives a best tuned system is plain wrong.

5.

Poor connection Management

- **Misunderstands the overhead of connections. poor connection management.**
  - Large value for max_connections
  - Large number of idle connections and idle in transactions

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connection Management

- Each connection creates a backend process
- Not much point in having connections greater than 10x of CPU count (A generic rule of thumb)
- high max_connection than what host can accommodate is an open door for DoS attacks.
- Creation of new database connection is costly.
- There is huge overhead in maintaining connections (snapshots, lock management and memory)
- Importance of connection pooler

6.

Parameters

Frequent Areas of outages and poor performance

- Autovacuum, workers, vacuum_cost_limit
- Work_mem & maintenance_work_mem
- checkpointing and bgwriter

Parameters has to be adjusted according to host machine and workload.

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7.

Multi-Tenancy

- Multi-tenancy is commonly used in other database system to reduce the licence cost.
- Not a valid reason for PostgreSQL.
- Single fatty database is a bad idea.
- Database softwares has many contention points including the concurrency control.
- Noisy neighbour problem in multi-tenancy is hard to tackle.

8.

Quick decision - DBaaS

- **Jumping to DBaaS Solutions as the provisioning is easy.**

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DBaaS Challenges

- **How do we upgrade?**
  - In-place upgrade of a big size database
  - pg_upgade with hardlink option
  - predictable downtime?
- **Troubleshooting.**
  - Dashboard is not enough. Linux tools are very essential.
  - Indepth analysis of CPU / IO utilization.
- **Can we restore**
  - Specific WALs?
  - Backups which are not restorable to the way we want is as good as **No backup**
- **Tablespaces**
- **Segregation of Disks**
  - A database system is mostly IO centric.

DBaaS Challenges

- **Extensions of choice**
  - columnar store, sharding, time series data, etc.
  - plpython
- **Custom Development of extensions**
- **DR capability testing - compliance requirements**
- **Custom Dictionary for text searches**
- **Logical replication slot continuity**
  - What is possible with Patroni.
- **Costs high**
  - 2x, upto 5x are reported : https://news.ycombinator.com/item?id=24608538

9.

Usage of “PostgreSQL” like software

- **PostgreSQL derivatives and “Compatible” Softwares**

Want to edit, but don't see an edit button when logged in? Click here.

PostgreSQL derived databases

A list of PostgreSQL derived forks and rebranded distributions in alphabetical order.

Name	Vendor	License	Availability	Notes
AgensGraph	Bitnine	Apache2	2016-	PostgreSQL + Graph Model features (Support graph storage and Cypher query language)
Aster Data	Teradata	Proprietary	2005-....	PostgreSQL + Map/Reduce
BDR	2ndQuadrant	BSD	2014-	PostgreSQL Multi Master, contributed actively back to Core PG
Bizgres	Greenplum	BSD	2005-2007	PostgreSQL + BI features
Cybercluster	Cybertec	BSD	2007-2010	Clustering (pgCluster fork)
Greenplum Database	Greenplum	Apache2	2005-....	PostgreSQL + BI features (formerly known as "Bizgres MPP") [1]
ExtenDB	ExtenDB	Proprietary	2003-2007	PostgreSQL + BI Features [2]
FUJITSU Enterprise Postgres	Fujitsu	proprietary	2006-....	Full PostgreSQL compatibility with additional functionality [3]
GresCube	NTT DATA	Proprietary	2012-....	Database appliance solution based on PostgreSQL [4]
GridSQL	EnterpriseDB	GPL	2007-2010	PostgreSQL + BI Features (formerly ExtenDB) [5]
Great Bridge PostgreSQL	Great Bridge LLC	BSD	1999-2001	PostgreSQL re-distribution
HadoopDB	Yale University	Apache License V2.0	2009-....	PostgreSQL + shared-nothing cluster + Hadoop [6]
Hadapt	Teradata	Proprietary	2011-....	HadoopDB fork
Mammoth	Command Prompt	BSD	2005-2010	PostgreSQL + proprietary replication + extensions
Netezza	IBM	proprietary	2002-....	Appliance based on PostgreSQL SQL engine
NuSphere UltraSQL	NuSphere	proprietary	2002-2003	Native Win32 port of PostgreSQL
ParAccel	Actian	proprietary	2005-....	PostgreSQL + BI features [7]
Pervasive PostgreSQL	Pervasive	BSD	2005-2006	PostgreSQL re-distribution
pgCluster	SRA	BSD	2002-2005	Clustering (Share Nothing)
pgCluster-II	SRA	BSD	2006-2007	Clustering (Shared Disk)
pgPool-II	pgPool GDG	BSD	2006-....	Clustering (Connection Pooling / Replication / Load-Balancing)
PipelineDB	PipelineDB	GPL v3	2015-....	Streaming SQL
PostgresForest	NTT DATA	BSD	2006-2010	Clustering / PostgresForest is a fork of the JDBC driver, not from the backend code.
EDB Postgres Advanced Server	EnterpriseDB	proprietary	2008-....	PostgreSQL + Oracle compatibility + security + performance tools + developer tools + DBA tools, formally Postgres Plus Advanced Server / EnterpriseDB AS [8]
Postgres Pro Enterprise	Postgres Professional	proprietary	2016-...	PostgreSQL + enterprise features [9]
Postgres-R	PGDG	BSD	2006-2010	Clustering
Postgres-X2	PGX2DG	BSD	2015-	Clustering (formerly Postgres-XC)
Postgres-XC	PGXCDG	BSD	2010-2013	Clustering [10]
Postgres-XL	PGXLDG	BSD	2014-....	Clustering

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What is PostgreSQL

- What you get from postgresql.org is PostgreSQL
- Stability and Availability.
- Performance.
- Quality of code.

- “XYZ PostgreSQL” or “ABC PostgreSQL” are not PostgreSQL. Expect bugs and problems.
- Performance claims, be sceptical. test with your load.
- Lock-in

10.

Extensions

- **Major cause of crashes reported to us**
- **Performance overhead.**

Extensions

- **Use when it is not avoidable**
- **unload / remove when not in use**
- **Native features like partitioning is powerful enough.**

Antoine de saint-exupéry

Perfection is achieved,

not when there is nothing more to add,

but when there is nothing left to take away.

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11.

High Availability

- Assess the real objectives and business value.
- What is at minimum required.
- Take the most widely used / popular in the community.
- Keep the recommendations a check.

Perceived HA is Not HA

Story of 8 hour outage.

PostgreSQL -> PgPool -> HAproxy with Zookeeper

- Automatic pgpool starting
- Zookeeper managing the DCS

Availability 9s are to be validated by actual data

- Simple systems are found to give better actual availability.
- Measurement and Interpretation is important.
  - https://en.wikipedia.org/wiki/High_availability
  - Outage due to any dependent component also accounted for the unavailability by very definition.
- Unacceptable performance also accounted for unavailability.

Mean time between failures also need to be measured and can make more sense than 9s.

12.

Poor use of Indexes

- **Partial Indexes are seldom used. many are not even aware**
- **Expression indexes**

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13.

Data Retention

Anything ever growing in size is not sustainable. But Cancerous

Data Retention

- **Partitioning**
- **Archive tables.**
- **Purging.**

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14.

Decision making

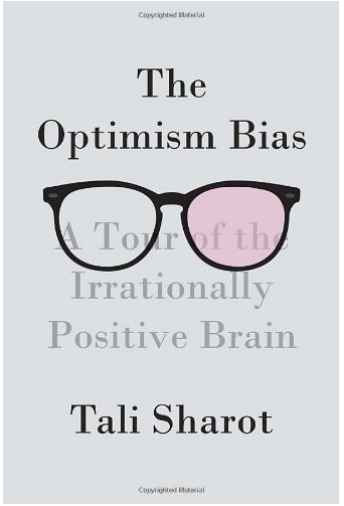
DEV

- Excitement
- Quick Decisions
- Advantages

Vs

Ops

- Skepticism
- Critical
- What are the objectives



The inclination to overestimate the likelihood of encountering positive events and underestimating the likelihood of encountering negative events.

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Test of Time

Those who walks in the front, steps on the land mine

- Assess how popular is certain technologies
- Get unbiased information (collect plus and minus)
- Test the waters - non-critical environment

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Ex:
Version Upgrade

- Dev and Test environments first - Incremental
- Watch and report issues - Assess possible problems
- Demand End-to-End testing.
- Wait for second minor version - Reduce the risk
- Three trial runs for Main production upgrade and prepare runbook.

Q & A