POSTGRESQL CONFIGURATION FOR *HUMANS*

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//ABOUT ONGRES

- **OnGres** (ON PostGRES) is an IT firm specialized on R&D on Databases, more specifically PostgreSQL, developing products that complement the PostgreSQL's ecosystem.
- **OnGres** is a global reference in **corporate level** services and products for **PostgreSQL** ecosystem.
- Active members of the PostgreSQL Community:
  - Founders of **PostgreSQL Spain**, one of the largest PUGs in the world, with about 900 members.
  - Trustees of Fundación PostgreSQL, a non-profit Foundation, and organizers of **PostgreSQL Ibiza** (pgibz.io).

//POSTGRESQL CONFIGURATION

- Mainly ***postgresql.conf*** (here's most of the meat).
- Authentication: ***pg_hba.conf*** (and ***pg_ident.conf***).
- Replicas: ***recovery.conf*** (may be merged soon).
- Some ***initdb*** parameters.
- Per-object settings (eg. ***fillfactor***).

Advanced stuff:

- Developer parameters.
- Compile-time #defines.

//WHY CONFIGURE POSTGRESQL?

- Otherwise, it only listens on localhost.
- You can only replicate by default in >= 10.
- To enable WAL archiving.
- Application developers say they get “connection refused!”
- Set defaults for client connections.
- Load extensions that required shared libraries.
- Enable checksums (*initdb*!)
- Compatibility with older versions.

ANY OTHER REASON? ;)

//PERFORMANCE, PERFORMANCE, PERFORMANCE (I)

Don't,
Don't,
Don't.

Usual performance optimization advice.

Do,
Do,
Do.

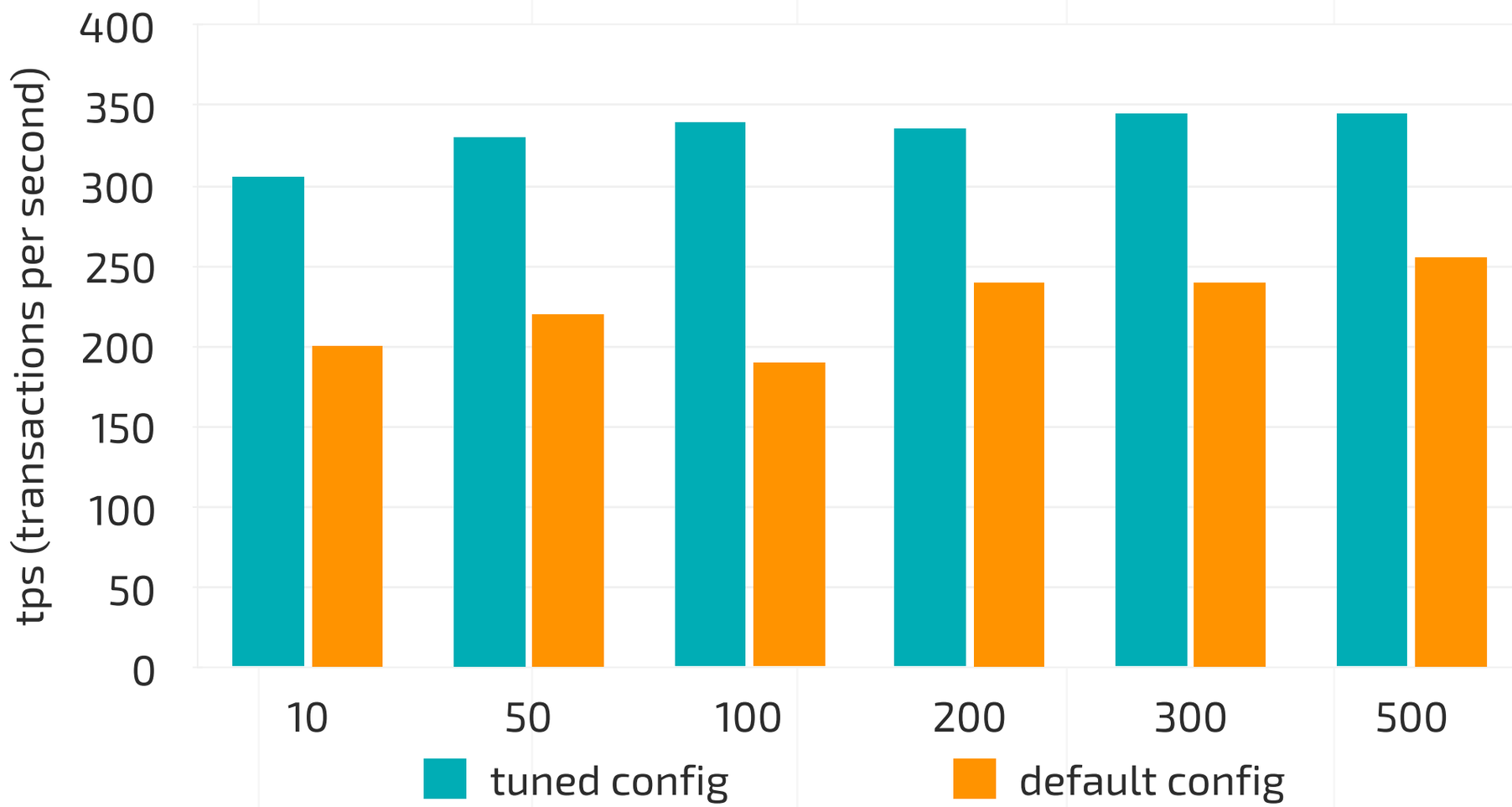
Usual **PostgreSQL** advice.
(*unless you run on a Raspberry PI 1st gen*).

- Run your own app-centric benchmarks.
- *pg_bench* is just one benchmark more.

ALL THE USUAL PRECAUTIONS ABOUT BENCHMARKS APPLY

//PERFORMANCE, PERFORMANCE, PERFORMANCE (II)

pg_bench, scale 2000, m4.large (2 vCPU, 8GB RAM, 1k IOPS).



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//PERFORMANCE, PERFORMANCE, PERFORMANCE (III)

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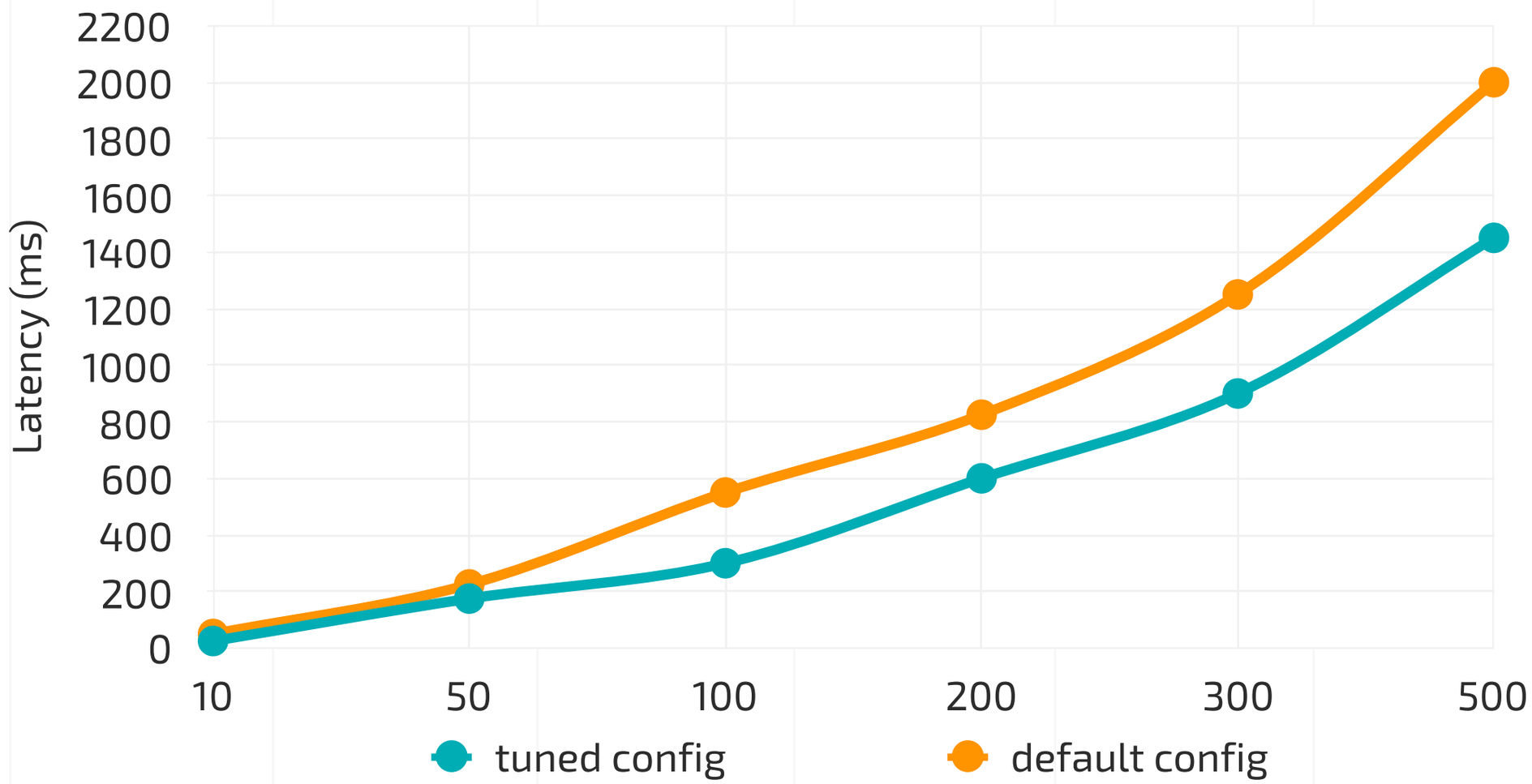

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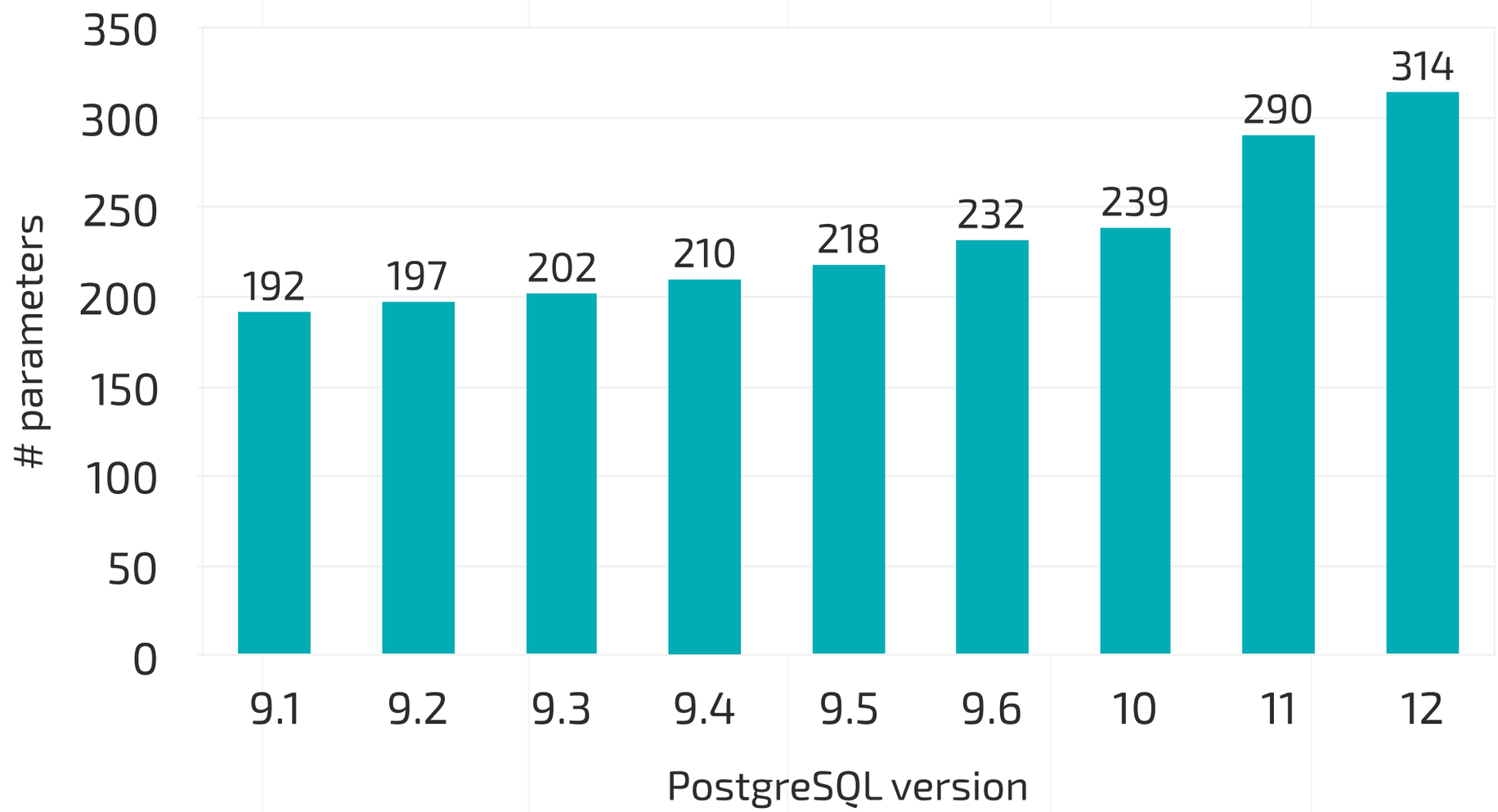
//POSTGRESQL.CONF PARAMETERS

- More than 200 parameters (*no kidding!*)
- Classified into 40 categories / subcategories.
- 650 lines, 23Kb *sample* config file.

How many to tune? **2? 5? 10? 20? 40? 100?**

- Parameters are *integer*, *real*, *string*, *enum*, *real* or *bool*. Numeric values may have units (or are unit-less).
- Some units are a bit uneasy (like “blocks of 8Kb”) or too synthetic (*cpu_tuple_cost*).

//TUNABLE POSTGRESQL.CONF PARAMETERS



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SOME IDEAS ABOUT POSTGRESQL TUNING...

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//DISCLAIMER

- No, you won't get here final numbers on how to tune your *postgresql.conf.*
- Only a few dozens parameters discussed here.
- Only hints provided: do your homework.
- My opinion may differ from other's.
- I am probably wrong.
- YMMV

(YOU GET THE POINT)

//INITDB

- Sometimes run on your behalf (Debian/Ubuntu), bad for selecting non defaults.
- ***-E (encoding)***. Use UTF-8 unless you know what you do.
- ***--locale***, ***--lc_collate***, ***--lc-ctype***.
- ***--username:*** If 'postgres' is not the superuser.
- ***--data-checksums:*** Enable them!

//DB CONNECTIONS 101 (I)

- ***max_connections*** is a hard limit.
- PostgreSQL will reject connections over this number.
- Users not happy.
- Default is 100.
- “My app has more 100 concurrent users!”

SOLUTION IS OBVIOUS: RAISE *MAX_CONNECTIONS*!

//DB CONNECTIONS 101 (II)

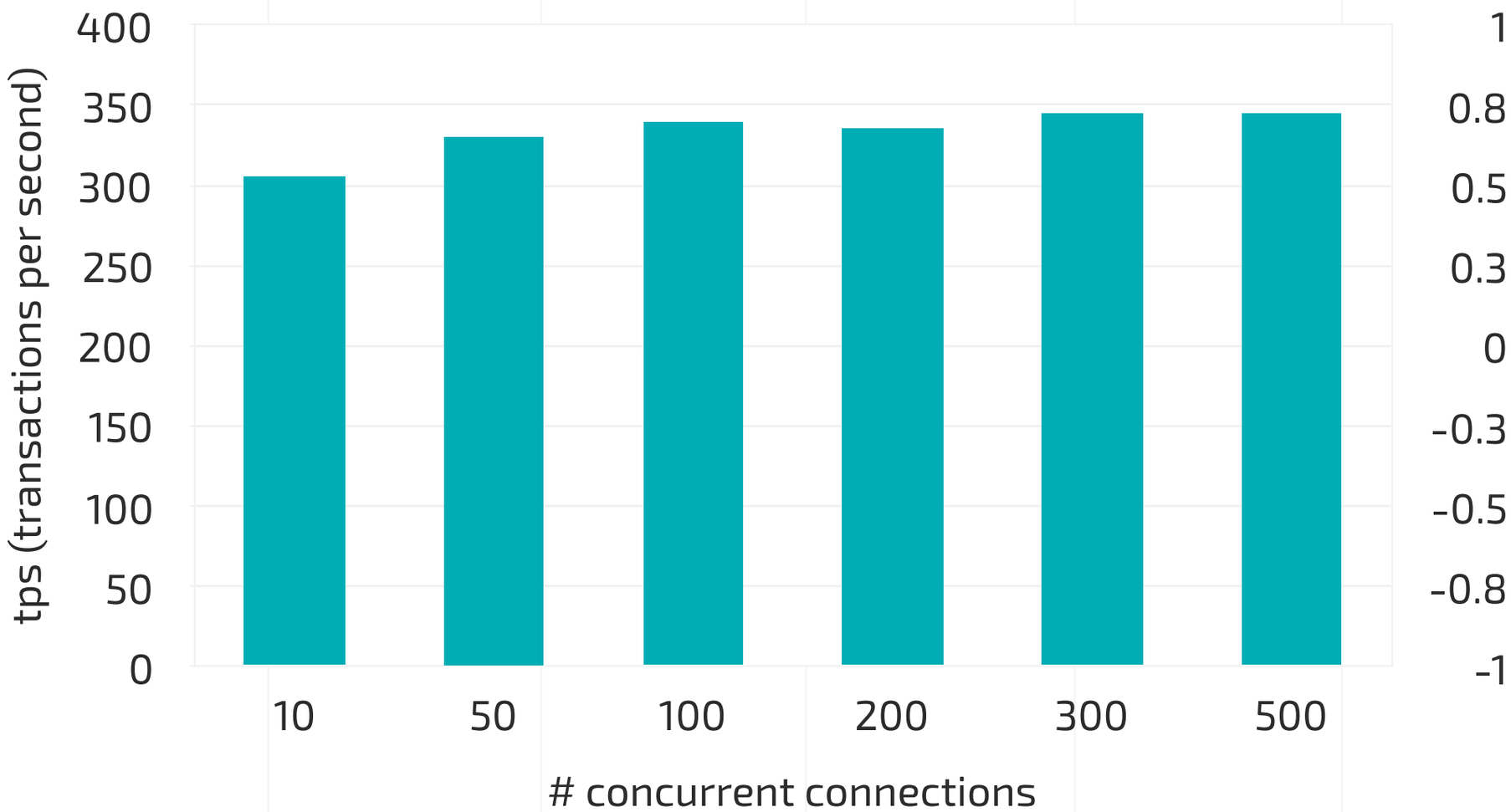
~~SOLUTION IS OBVIOUS: RAISE *MAX_CONNECTIONS*!~~

- One process per connection (excl. parallelism!)
- One process handled by one core
- How many cores do you have?
- Sure, you have a multi-process, time-sharing OS but what is the scheduling overhead with many processes?

EVEN WORSE: CACHE TRASHING!

//DB CONNECTIONS 101 (III)

pg_bench, scale 2000, m4.large (2 vCPU, 8GB RAM, 1k IOPS).



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//DB CONNECTIONS 101 (III)

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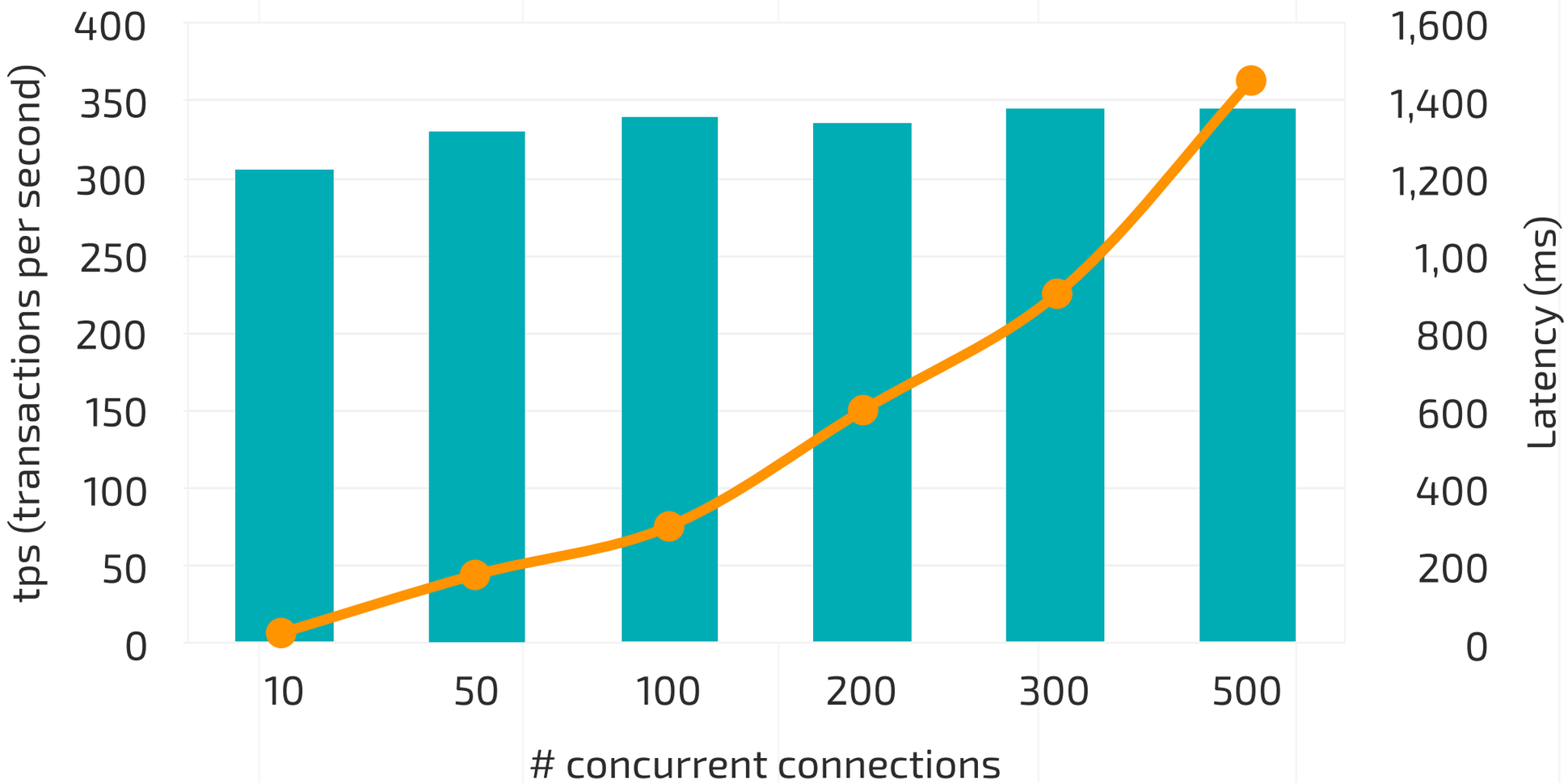

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//DB CONNECTIONS 101 (V)

- Solution is obvious: **lower *max_connections***!
- But how we solve the connection refused problem?
- ***PgBouncer***!
- Size your connections almost 1:1 *pgbouncer:max_conns.*
- Use this formula:

$$\text{CONNECTIONS} = \frac{\text{CORES}}{\text{\% EFFECTIVE UTILIZATION CONNECTION}} \text{ X SCALE FACTOR}$$

//SHARED_BUFFERS

- The first recommendation everybody tells you.
- Set it to 1/4th of RAM and *effective_cache_size* 3/4th.
- ~~Done!~~
- 1/4th too low on low memory, too high on high memory.
- **Benchmark, benchmark, benchmark.**
- Is the database dedicated in the host? OS memory?
- How much memory other PostgreSQL parts use, like *maintenance_work_mem* or all the memory used by query processes?

//WORK_MEM

- Max local process memory used for operations like sort and joins in queries.
- Not written in stone: users can SET it overriding its value.
- But if more memory is used, it spills to disk (and may use different algorithm) reducing performance.
- Not the same if you are OLTP, OLAP, DW (small to very large).
- Raise it from defaults, but don't forget it could be times (*max_connections* * max nodes query).

//OTHER MEMORY/DISK TUNABLES

- ***maintenance_work_mem***: vacuum, create index, check FKs… raise it.
- ***{min,max}_wal_size***: it's only disk space, but too low will cause excessive checkpoints. Make min at least 1GB, max several GB up to 50-100GB.
- ***stats_temp_directory***: run on a not very small RAMdisk.

//THIS REQUIRES RESTART, THINK CAREFULLY

- ***listen_addresses*** (take care with '*'), port.
- ***ssl:*** activate only if needed, use pooling!
- ***huge_pages:*** benchmark, benchmark, benchmark (typically off).
- ***shared_preload_libraries:*** add your extensions beforehand!
- ***logging_collector:*** *on*.
- ***wal_level:*** replica or *logical*.
- ***archive_mode***, ***archive_command*** = *'/bin/true'* if you don't use archiving.
- ***cluster_name***.

//THE TYRANNY OF *MAX_**

- Most of the *max_** also require restart.
- Sometimes hard to estimate, but restarting the database is pretty bad: raise limits and control usage.
- ***max_wal_senders:*** replicas, backups, make room.
- ***max_replication_slots***.
- ***max_worker_processes***, ***max_parallel_workers_per_gather***, ***max_parallel_workers***.
- ***autovacuum_max_workers*** (# cores for cleanup?)
- ***max_prepared_transactions*** (2PC, 0 by default).

//AUTOVACUUM / VACUUM (I)

- Almost always too conservative.
- Bloat is one of the most frequent operational burdens.
- Hard to get it right: analyze and re-tune periodically.
- Some parameters are set to "*-1*" which means "look at these numbers from the vacuum parameters".
- ***autovacuum_{vacuum,analyze}_scale_factor:*** you may override on a per-table level.

//*AUTOVACUUM / VACUUM* (II)

General advice:

- Raise *vacuum_cost_limit* significantly.
- Reduce *autovacuum_vacuum_cost_delay*.
- Use more *autovacuum_max_workers* if you have many cores.

//CHECKPOINTS AND *BGWRITER*

- You typically want to spread checkpoints farther apart (raise *checkpoint_timeout*).
- *min_wal_size* 1GB min.
- Log checkpoints and look for warnings.
- Raise *checkpoint_completion_target*, eg. 0.9, but study your I/O patterns, *shared_buffers*, *wal size*.
- Increase bgwriter activity, very conservative default:
  - Decrease *bgwriter_delay*.
  - Increase *bgwriter_lru_maxpages*.

//LOGGING

- “Only” 24 parameters (plus some others).
- Spend some time here, It pays off when analyzing your db.
- Turn on:
  - *logging_collector*.
  - *log_checkpoints*.
  - *log_connections*, *log_disconnections*.

//OTHER INTERESTING PARAMETERS

- *password_encryption* use SHA-256 if possible (>= PG 10).
- *effective_io_concurrency* (how many “spindles” your I/O has?)
- *max_standby_{archive,streaming}_delay* and *hot_standby_feedbak:* keep replication query conflicts burden on the primary or secondaries?
- *default_statistics_target:* if setting by table is not your job.
- Adjust the *random_page_cost* / *seq_page_cost* (4.0 / 1.0 by default), so that it is lower on SSD (start with 1.x) or indexes may not be used when it could be beneficial.

WAS THAT TOO MUCH? TOOLS TO HELP?

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//WAS THAT TOO MUCH? TOOLS TO HELP? (I)

Parameters of your system

DB Version — what is this?

10

OS Type — what is this?

Linux/OS X

DB Type — what is this?

Web applications

Total Memory (RAM) — what is this?

16 GB

Number of Connections — what is this?

200

Generate

PostgreSQL settings (add/modify this settings in `postgresql.conf` and restart database):

```
# DB Version: 10
# OS Type: linux
# DB Type: web
# Total Memory (RAM): 16 GB
# Number of Connections: 200

max_connections = 200
shared_buffers = 4GB
effective_cache_size = 12GB
work_mem = 20971kB
maintenance_work_mem = 1GB
min_wal_size = 1GB
max_wal_size = 2GB
checkpoint_completion_target = 0.7
wal_buffers = 16MB
default_statistics_target = 100
```

//WAS THAT TOO MUCH? TOOLS TO HELP? (II)

PostgreSQL Configuration Tool 2.0 beta

TUNING ADVISOR ABOUT

SHARE! EXPORT

GNU/Linux Based | 64 Bits (x86-64) | 2

Application Profile: General web applications | Max connections *: 100 | PostgreSQL version: 9.6

RUN IT NOW!

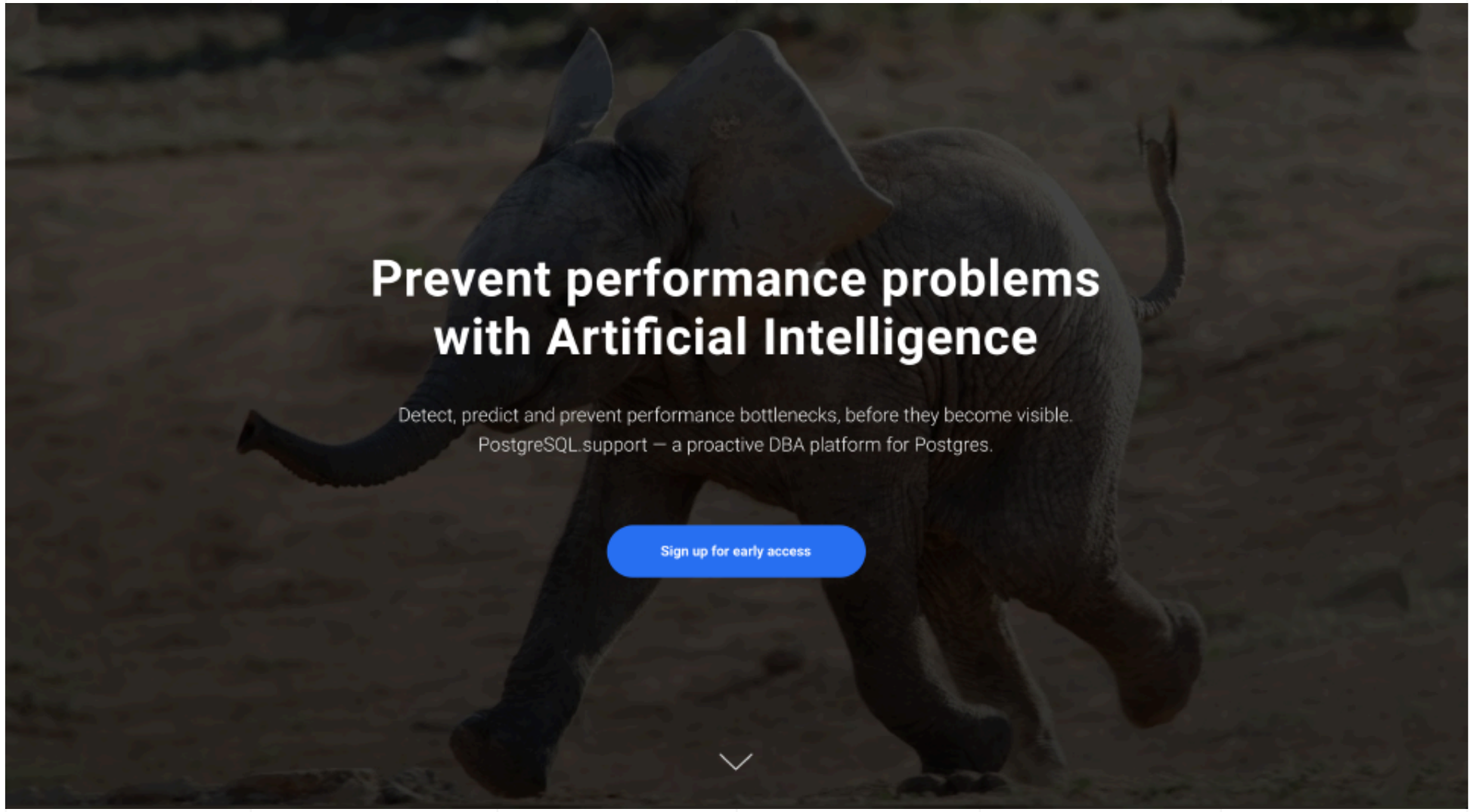
Memory Configuration

	Default Value	WEB	OLTP	DW	Mixed	Desktop
shared_buffers *(integer)*	128MB	512MB	512MB	512MB	512MB	128MB
effective_cache_size *(integer)*	4GB	2GB	2GB	2GB	2GB	512MB
work_mem *(integer)*	4MB	20MB	20MB	10MB	10MB	4MB
maintenance_work_mem *(integer)*	64MB	128MB	128MB	256MB	128MB	128MB

Checkpoint Related Configuration

	Default Value	WEB	OLTP	DW	Mixed	Desktop
min_wal_size *(integer)*	80MB	512MB	1GB	2GB	512MB	2GB
max_wal_size *(integer)*	1GB	2GB	3GB	6GB	2GB	1GB
checkpoint_completion_target *(floating)*	0.5	0.7	0.9	0.9	0.9	0.5

//WAS THAT TOO MUCH? TOOLS TO HELP? (III)



POSTGRESQL WANTS A NEW CONFIGURATION TOOL

(IMVHO)

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//POSTGRESQLCO.NF (I)

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POSTGRESQL**CO.NF** DOCUMENTATION PUBLIC CONFIGURATIONS FAQ

CONFIGURED

CATEGORIES

NAMESPACE	NAME	VALUE	INFORMATION	STATUS	RESTORE	EDIT
	archive_timeout	50	Forces a switch to the next WAL file if a new file has not been started within N seconds			
namespace_01	checkpoint_warning	true	Enables warnings if checkpoint segments are filled more frequently than this			
	ssl_passphrase_command_supports_reload	on	Also use ssl_passphrase_command during server reload			
namespace_02	wal_buffers	GREATEST({DBInstanceClassMemory*1024/63963136},65536)	Sets the number of disk-page buffers in shared memory for WAL			

+ ADD PARAMETER

SEPARATE OFFICIAL/CUSTOM

DEFAULT VALUES

CATEGORIES

NAME	VALUE	INFORMATION	TUNED	EDIT
allow_system_table_mods	off	Allows modifications of the structure of system tables		
application_name		Sets the application name to be reported in statistics and logs		
archive_command		Sets the shell command that will be called to archive a WAL file		
archive_mode	off	Allows archiving of WAL files using archive_command		
archive_timeout	0	Forces a switch to the next WAL file if a new file has not been started within N seconds		
array_nulls	on	Enable input of NULL elements in arrays		
authentication_timeout	60	Sets the maximum allowed time to complete client authentication		
autovacuum	on	Starts the autovacuum subprocess		
autovacuum_analyze_scale_factor	0.1	Number of tuple inserts, updates, or deletes prior to analyze as a fraction of reltuples		
autovacuum_analyze_threshold	50	Minimum number of tuple inserts, updates, or deletes prior to analyze		
autovacuum_freeze_max_age	200000000	Age at which to autovacuum a table to prevent transaction ID wraparound		
autovacuum_max_workers	3	Sets the maximum number of simultaneously running autovacuum worker processes		
autovacuum_multixact_freeze_max_age	400000000	Multixact age at which to autovacuum a table to prevent multixact wraparound		

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//POSTGRESQLCO.NF (II)

- Drag&drop your *postgresql.conf*.
- Automatic validation.
- Publish and share your config.
- Download as *postgresql.conf*, *JSON*, *yaml*, *SQL*.
- Rest API.

SUBSCRIBE ON POSTGESQLCO.NF
TO BECOME A BETA TESTER!

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