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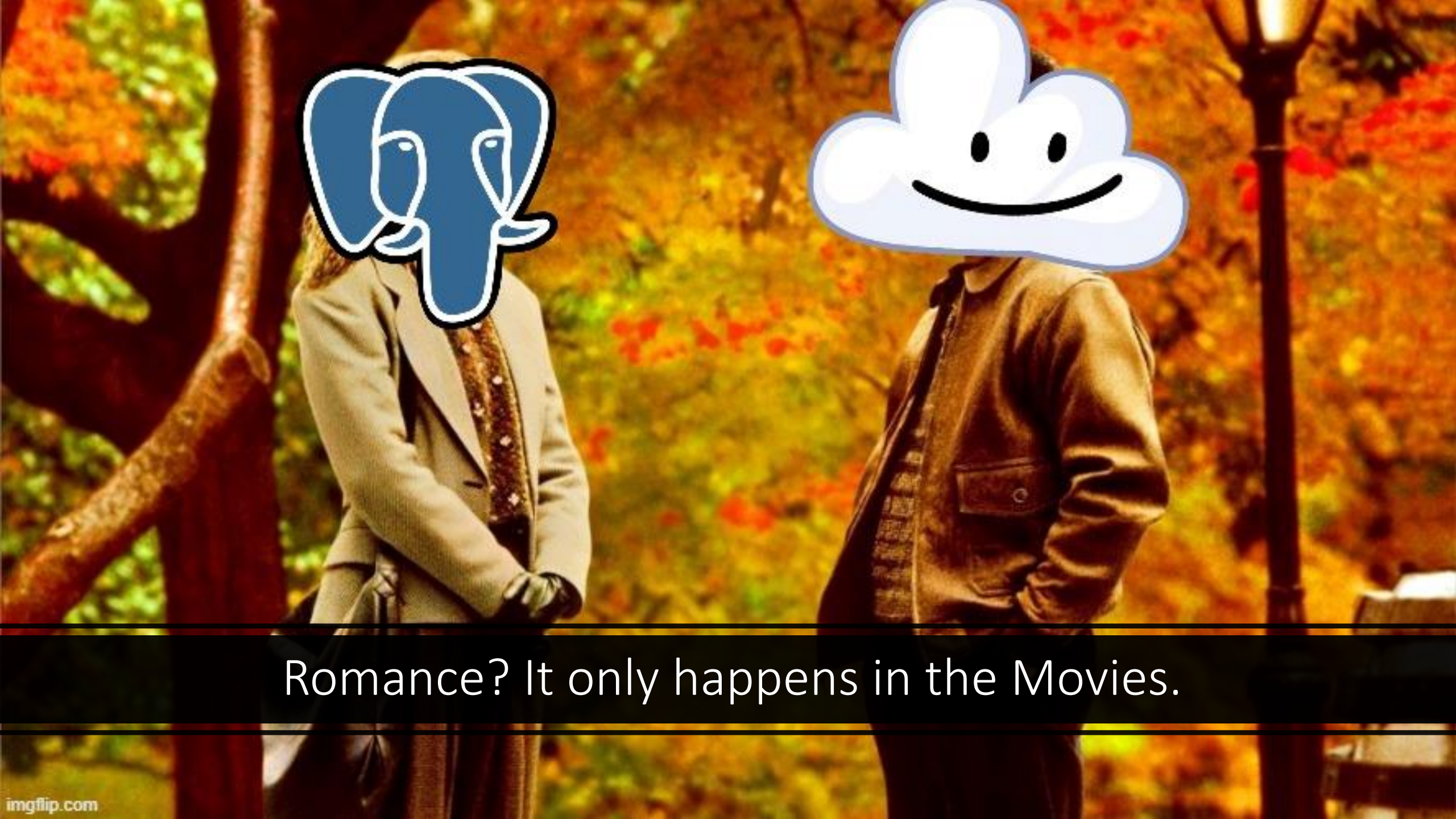
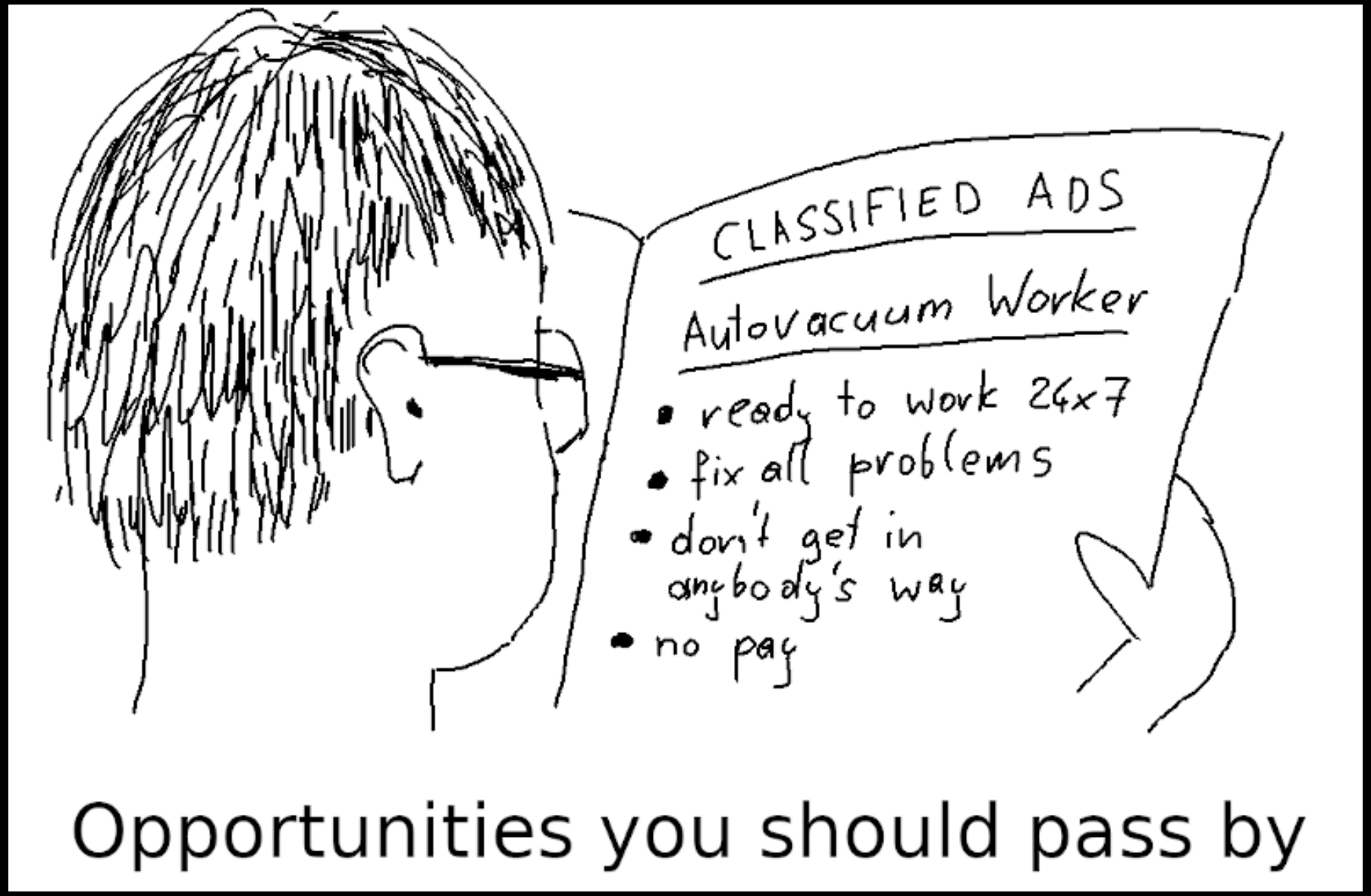
When Autovacuum Met FinOps: A Cloud Romance


Romance? It only happens in the Movies.
imgflip.com

Typical DBA/DEV Complaints

- "Autovacuum used to fly on bare-metal, but in the cloud, it feels like it's dragging forever!“
- "I've doubled the max_autovacuum_workers, yet dead tuples just keep stacking up“
- "Every time Autovacuum kicks in on that big table, our application queries start timing out!"

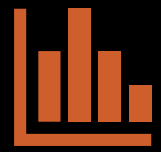
AutoVacuum : The most hard-working employee in your company.



Opportunities you should pass by

AutoVacuum

Removes dead tuples.



Updates planner statistics.

Updates visibility map.

Prevents txid wraparound failures.

Important Parameters

- Autovacuum throughput is constrained by the autovacuum_vacuum_cost_limit, autovacuum_vacuum_cost_delay and further limited by host restrictions on Cloud.

- Autovacuum_vacuum_cost_limit gets divided among number of workers specified by autovacuum_max_workers.

- Autovacuum_work_mem controls the amount of memory used by each worker.

How much io?

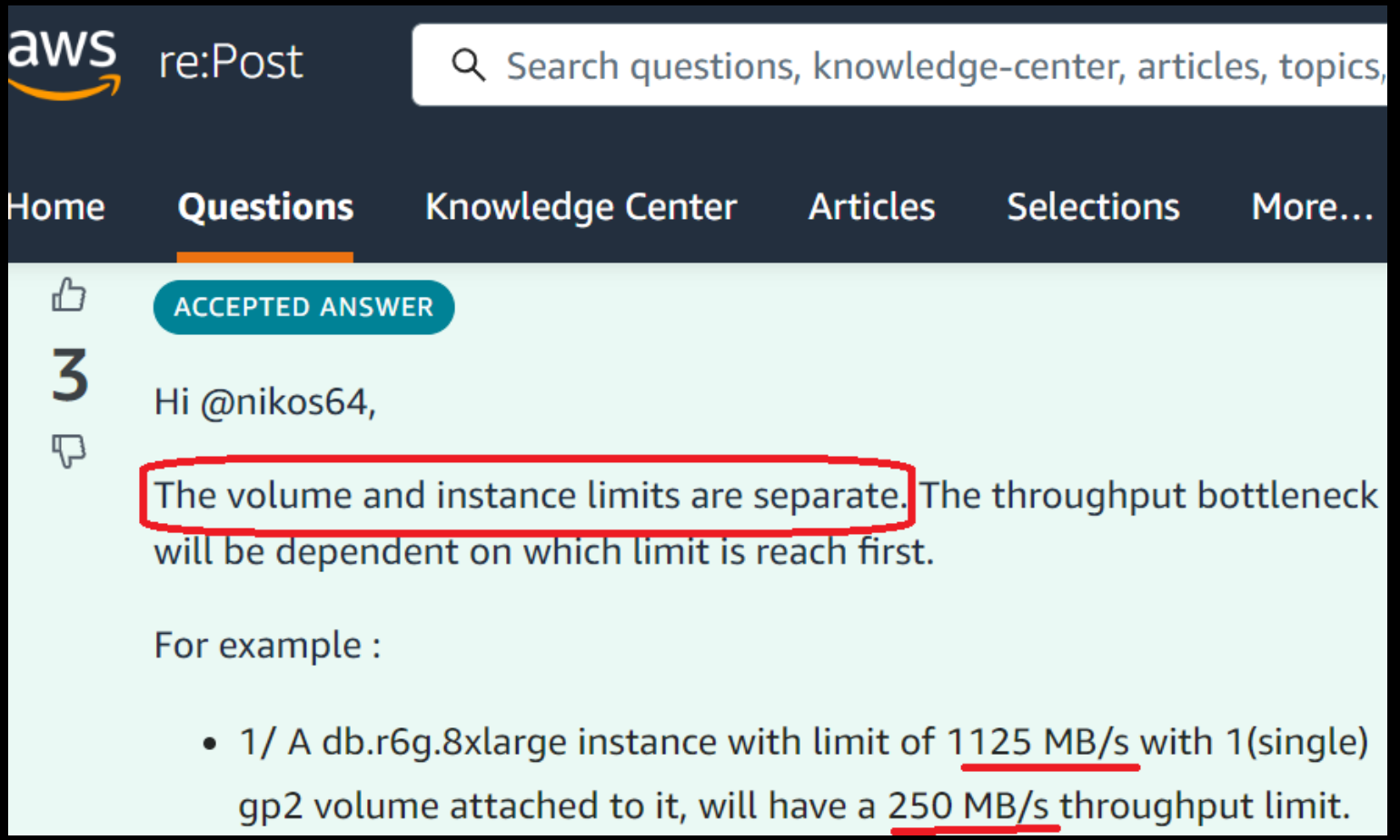
#At **most**, Autovacuum can do IO as shown below

Max Autovacuum throughput = (1000/autovacuum_vacuum_cost_delay) * (autovacuum_vacuum_cost_limit/vacuum_cost_page_hit) * 8 KB (default block_size)

#For PG17 default settings:

Max Autovacuum throughput = (1000/2) * (200/1) * 8 KB = 800MB per second

Instance and Storage both limit throughput



Instance throughput limit

Standard instance class : General purpose standard instances of latest graviton series offer better throughput upto 2.5GBps.
Gbps/Mbps here is in Bits hence division by 8 to get GB/s or MB/s.

Model	Core Count	vCPU*	Memory (GiB)	Storage	Dedicated EBS Bandwidth (Gbps)
db.m7g.large	-	2	8	EBS-Only	Up to 10
db.m7g.xlarge	-	4	16	EBS-Only	Up to 10
db.m7g.2xlarge	-	8	32	EBS-Only	Up to 10
db.m7g.4xlarge	-	16	64	EBS-Only	Up to 10
db.m7g.8xlarge	-	32	128	EBS-Only	10
db.m7g.12xlarge	-	48	192	EBS-Only	15
db.m7g.16xlarge	-	64	256	EBS-Only	20

Instance throughput limit

"Up to" is a very vague term. I found another piece of the puzzle in AWS document.

Instance type	Baseline / Maximum bandwidth (Mbps)	Baseline / Maximum throughput (MB/s, 128 KiB I/O)	Baseline / Maximum IOPS (16 KiB I/O)	NVMe	EBS optimization [2]
m7g.medium [1]	315.00 / 10000.00	39.38 / 1250.00	2500.00 / 40000.00	✓	default
m7g.large [1]	630.00 / 10000.00	78.75 / 1250.00	3600.00 / 40000.00	✓	default
m7g.xlarge [1]	1250.00 / 10000.00	156.25 / 1250.00	6000.00 / 40000.00	✓	default
m7g.2xlarge [1]	2500.00 / 10000.00	312.50 / 1250.00	12000.00 / 40000.00	✓	default
m7g.4xlarge [1]	5000.00 /	625.00 / 1250.00	20000.00 /	✓	default

Note

[1] These instances can support maximum performance for 30 minutes at least once every 24 hours, after which they revert to their baseline performance. Other instances can sustain the maximum performance indefinitely. If your workload requires sustained maximum performance for longer than 30 minutes, use one of these instances.

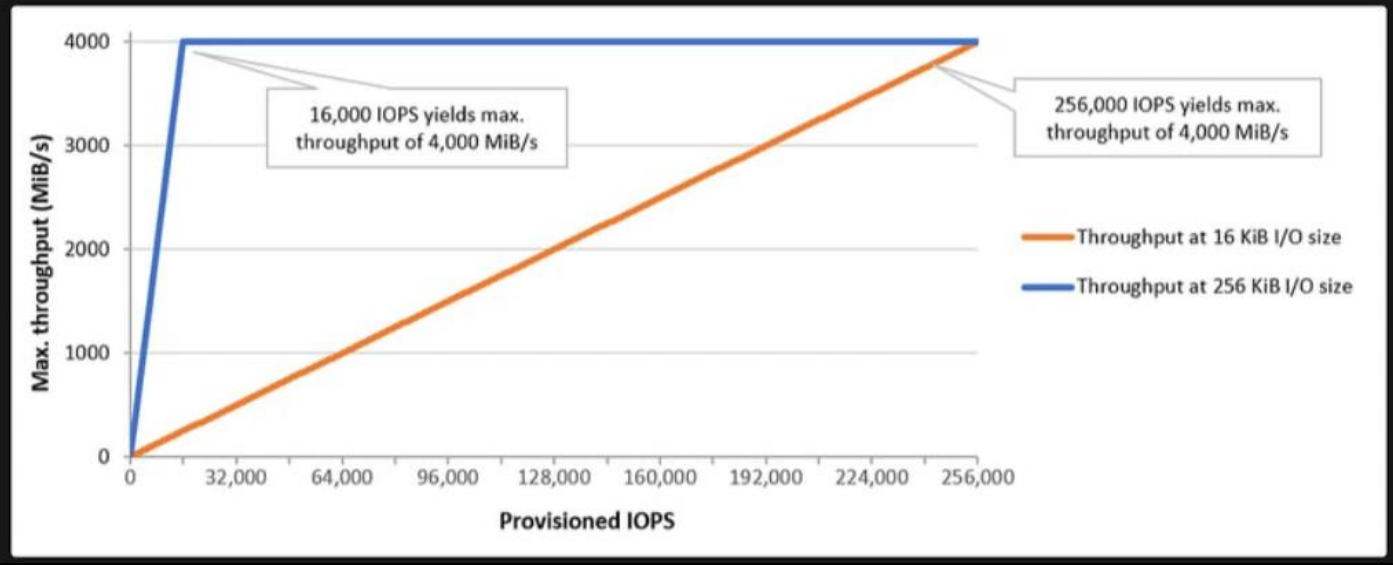
Since maximum performance is guaranteed for only 30 minutes per day, we will focus only on baseline values.

Storage throughput limit

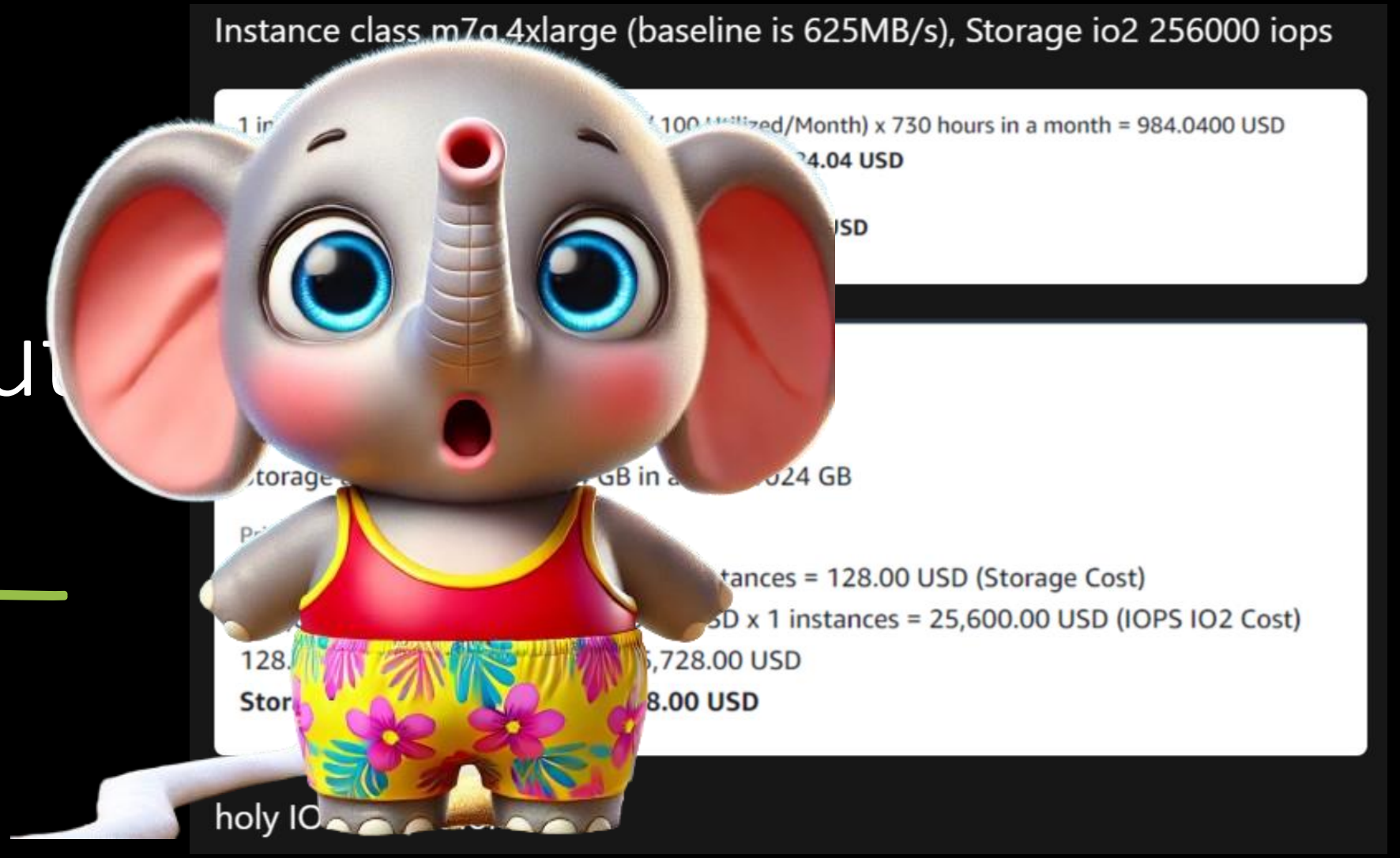
io2 :

- Throughput scales proportionally up to 0.256 MiB/s per provisioned IOPS. Maximum throughput of 4,000 MiB/s can be achieved at 256,000 IOPS with a 16-KiB I/O size and 16,000 IOPS or higher with a 256-KiB I/O size. For DB instances not based on the AWS Nitro System, maximum throughput of 2,000 MiB/s can be achieved at 128,000 IOPS with a 16-KiB I/O size.

For io2 we can reach up to 500MB/s as we crank up iops knob.



Storage throughput limit



GP3 saves the day

Don't worry GP3 saves the day.

▼ Show calculations

Unit conversions

Storage amount: 1 TB x 1024 GB in a TB = 1024 GB

Pricing calculations

16,000 iops / 1,024 GB = 15.63 IOPS to GB ratio (gp3)

4,000 MiBps / 16,000 iops = 0.25 IOPS to Throughput ratio

1,024 GB per month x 0.115 USD x 1 instances = 117.76 USD (Storage Cost)

16,000 IOPS - 12000 free GP3 iops = 4,000 billable gp3 iops

4,000 MiBps - 500 MiBps free throughput = 3,500 MiBps billable throughput

4,000 IOPS x 0.02 USD = 80.00 USD

3,500 MiBps x 0.08 USD = 280.00 USD

117.76 USD + 80.00 USD + 280.00 USD = 477.76 USD

Storage pricing (monthly): 477.76 USD

Estimate summary Info

Upfront cost	Monthly cost	Total 12 months cost
0.00 USD	1,461.80 USD	17,541.60 USD
		Includes upfront cost

Min. Config for 500MB/s throughput, 1TB db

Cloud	Storage (all SSDs but taking only cost-efficient type)	Compute (Instance class)	Monthly Cost (in US-East)
AZURE (Azure Database for PostgreSQL — Flexible Server)	Premium SSD (5K iops for 500MB/s)	D16ds_v5	$1407
AWS (Amazon RDS – Postgres)	GP3 (16K iops minimum for 500MB/s)	m7g.4xlarge	$1462
GCP (Cloud SQL – Postgres)	Zonal extreme-pd	8 vCPUs	$497

Why should you understand costs?

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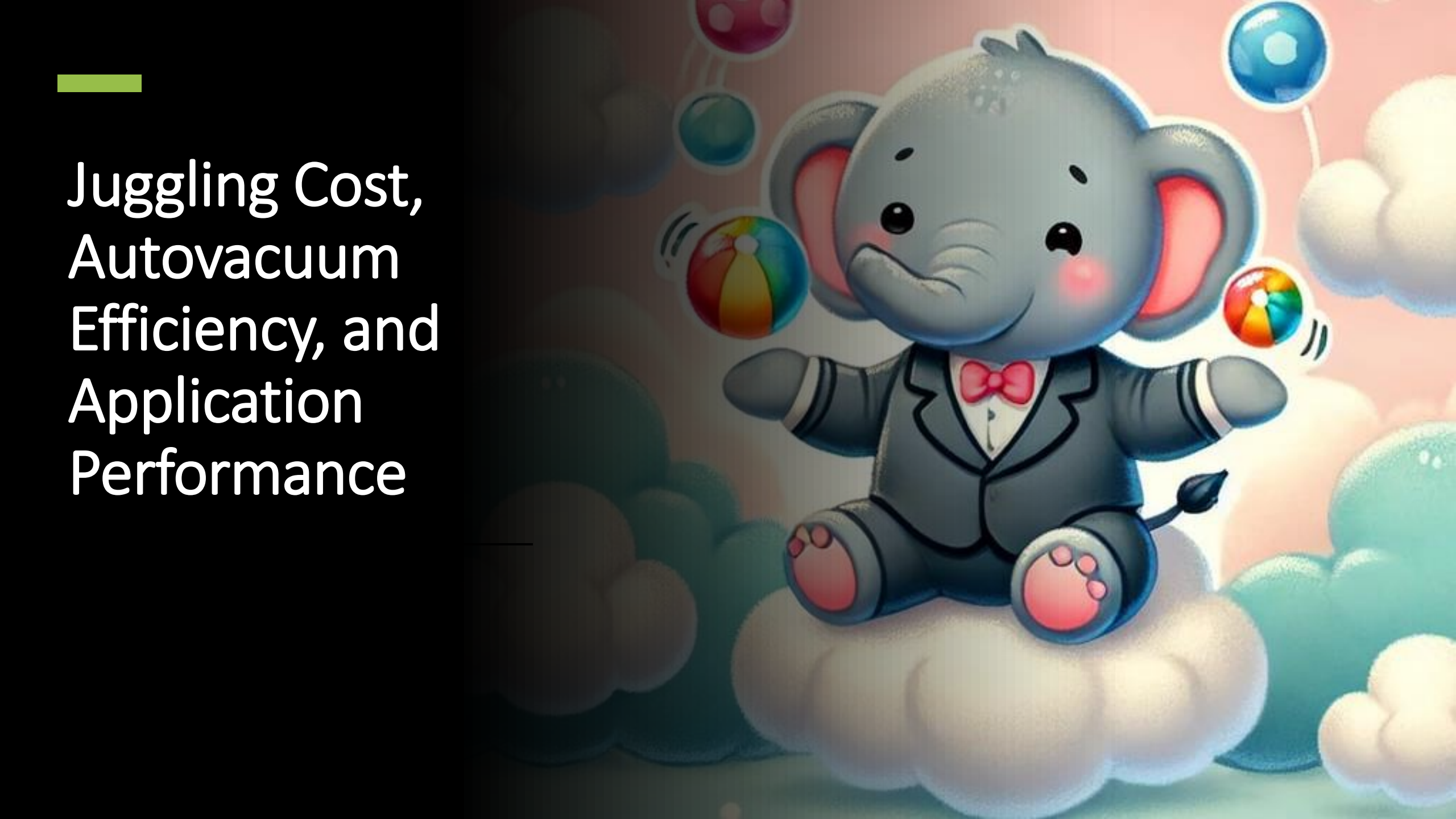
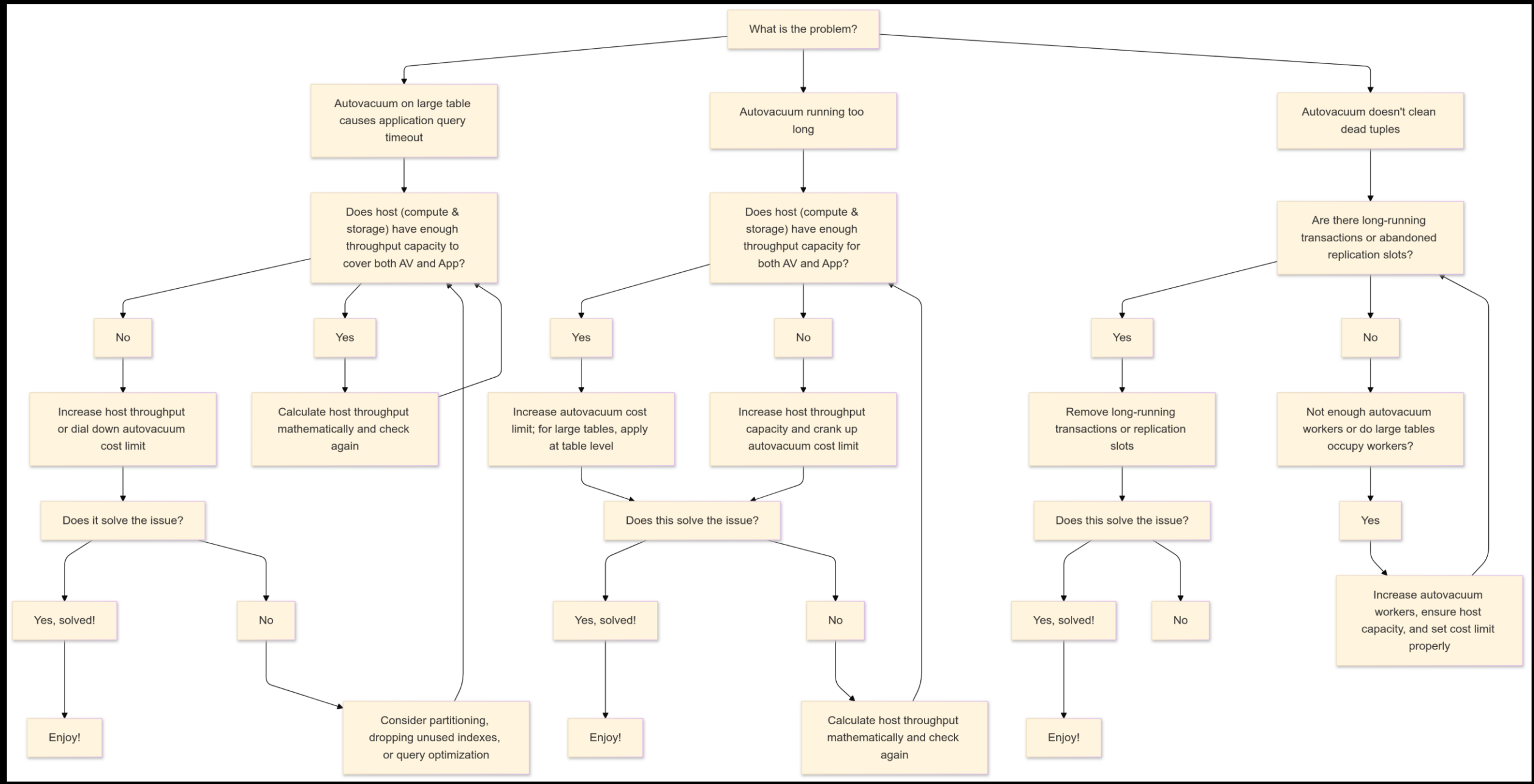
Juggling Cost, Autovacuum Efficiency, and Application Performance



AV Tuning Flow : A picture is worth a thousand words



The Low Hanging Fruit

$$\text{autovacuum\_work\_mem} = \text{LEAST}\left(\frac{\text{Total Memory} - (\text{shared\_buffers} + \text{session\_memory} + \text{reserve\_memory})}{\text{autovacuum\_workers}}, 1\ \text{GB}\right)$$

Example:
Total Memory = 64 GB
shared_buffers = 16 GB (25% of Total Memory)
work_mem = 32 MB
active_sessions = 100
idle_sessions = 500 (assume poorly configured connection pool for more realistic calculations)
idle_session_memory = 10 MB per idle connection
autovacuum_workers = 6

session_memory =(active_sessions*work_mem*hash_mem_multiplier)+ (idle_sessions*idle_session_memory)
Reserve OS Memory = Reserve 20% of Total Memory
autovacuum_work_mem = LEAST(3.9667GB,1GB) =1GB

Reason for autovacuum_work_mem 1GB restriction (Pre-PG17)

postgres / src / include / utils / **memutils.h**

Code | Blame | 209 lines (179 loc) · 6.99 KB

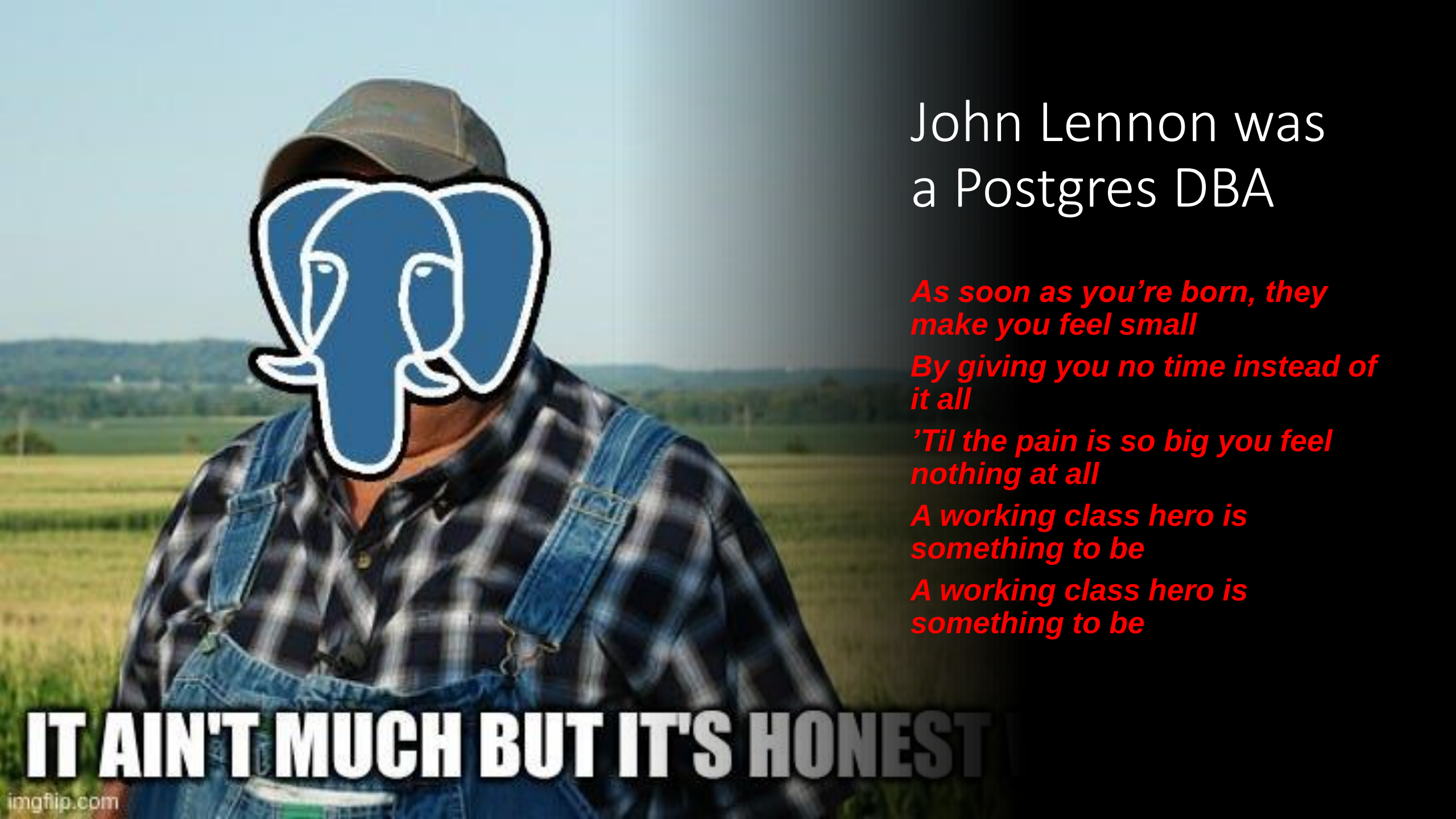
```
38      * compute twice an allocation's size without overflow.
39      */
40     #define MaxAllocSize    ((Size) 0x3fffffff) /* 1 gigabyte - 1 */
41
```

Budget constraints = Think creatively

- Consider partitioning problematic tables, Size of data and indexes reduces.
- Detect and drop unused indexes (since PG vacuums all indexes).
- Minimize long-running transactions (lower wasteful vacuum runs).
- If it still impacts application performance, you may need to dial back cost limit and increase cost delay.
- Always implement an Early Warning System for TXID wraparound (AWS offers a detailed guide on this).
- Last but not the least, upgrade to PG17 for improved vacuuming.

Adapt to the nature of the beast.

- Thousands of DB's (in cloud) => Start with less aggressive settings for AV.
- Implement early warning system for txid wraparound exhaustion.
- Set log_autovacuum_min_duration and do log mining, create automated alert for tables appearing repeatedly.
- Increase cost limit gradually on need basis.
- If just a few PET DBs then take scientific approach of calculating optimal value for all AV settings.



John Lennon was a Postgres DBA

As soon as you're born, they make you feel small

By giving you no time instead of it all

'Til the pain is so big you feel nothing at all

A working class hero is something to be

A working class hero is something to be

References:

https://www.percona.com/blog/tuning-autovacuum-in-postgresql-and-autovacuum-internals/

https://calculator.aws/#/

https://azure.microsoft.com/en-us/pricing/details/postgresql/flexible-server

https://cloud.google.com/sql/docs/postgres/pricing

Thank you

Database Comedy Blog

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