

CLOUD –POSTGRES HORSE RACE




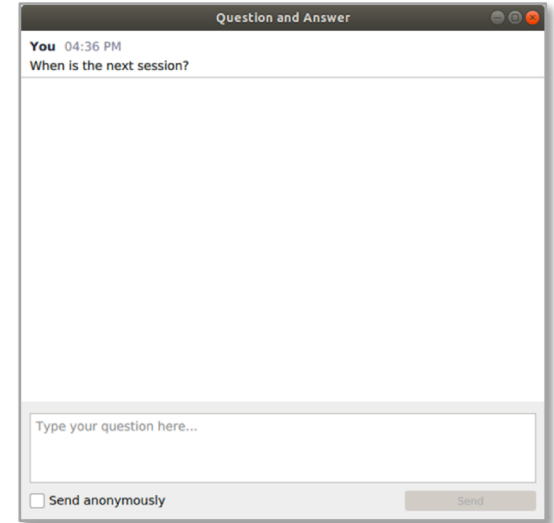
Tom Rieger

Senior Client Engineer



House Keeping

- We have a lot of materials to cover and plan on keep this within 53 1/2 minutes.
- In using Zoom's Webinar technology
 - Everyone is on <MUTE>
 - Questions are entered into the tool 
 - Online Polling will be used
 - We are recording the webinar and will share the private link shortly after the session



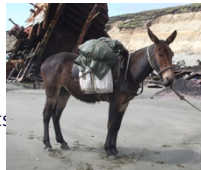
Database HORSE RACE – May 3rd



Live benchmark so everyone can see ‘the sausage made’

HammerDB

TPC-C Workload - Consistent workload, scale and concurrency



History of database benchmarking and sizing

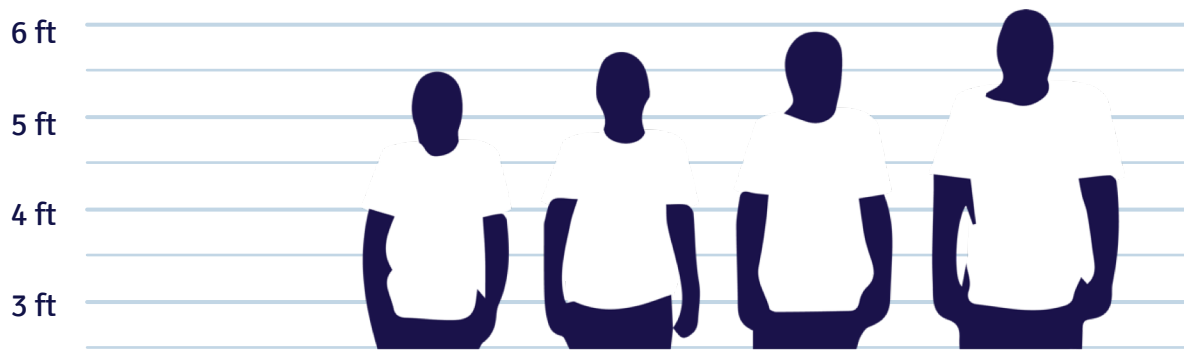
- General workloads
 - Transactional
 - Analytical
- Vendor-specific workloads
 - Database-specific
 - Vendor-specific – SAP SD
- More fit-for-purpose
 - Load testing
 - Performance testing
 - IO performance
- Historically benchmarks were focused on **performance NOT economics**

TPC®

\$\$

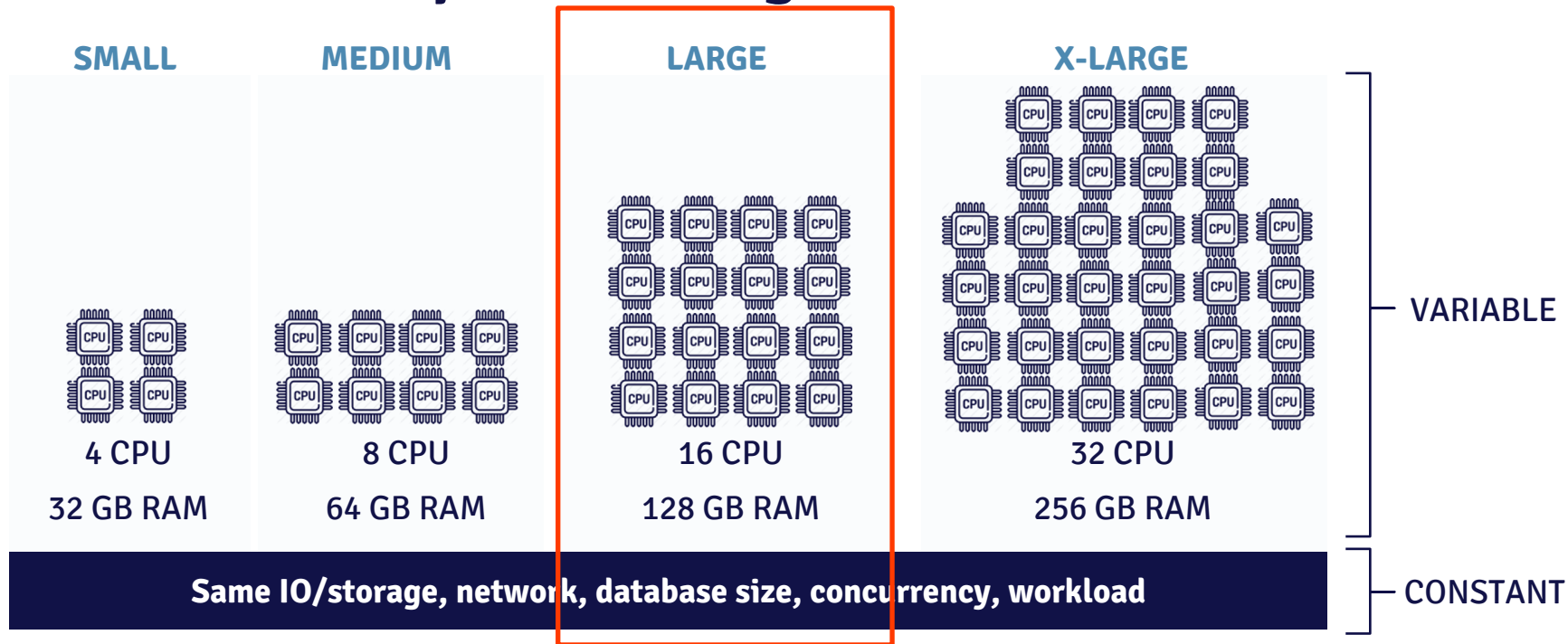


The cloud allows a more elastic 't-shirt' sizing



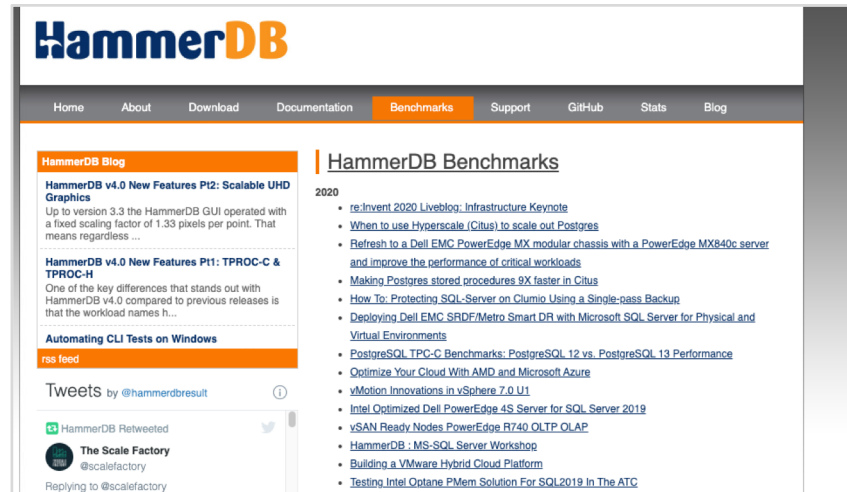
	S	M	L	XL
Name	Hector	Joe	Dan	Marcus
Height	5, 4	5, 7	5, 10	6, 1
Weight	125 lbs	160 lbs	170 lbs	225 lbs
Chest	33	33	35	42
Waist	32	32	36	38

Think of cloud provisioning as 't-shirt' sizes



Workloads for this effort – Why?

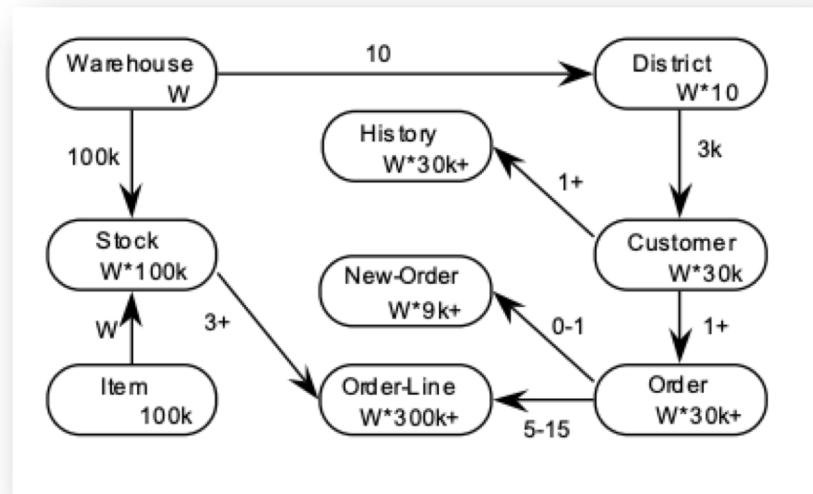
- HammerDB is open-source – evolving, community and free
- Standards based
 - TPC-C for transactional
 - TPC-H for analytical
- Works with all major databases – Oracle, SQLServer, DB2, MySQL, Postgres



The screenshot shows the HammerDB website. The header includes the HammerDB logo and a navigation menu with links for Home, About, Download, Documentation, Benchmarks, Support, GitHub, Stats, and Blog. The main content area is divided into two columns. The left column features a 'HammerDB Blog' section with two articles: 'HammerDB v4.0 New Features P12: Scalable UHD Graphics' and 'HammerDB v4.0 New Features P11: TPROC-C & TPROC-H'. Below the blog is an 'Automating CLI Tests on Windows' section with an RSS feed icon. A 'Tweets by @hammerdbresult' section shows a tweet from 'The Scale Factory' (@scalefactory) retweeted by HammerDB. The right column is titled 'HammerDB Benchmarks' and lists various benchmark articles from 2020, including 're:Invent 2020 Liveblog: Infrastructure Keynote', 'When to use Hyperscale (Citrus) to scale out Postgres', 'Refresh to a Dell EMC PowerEdge MX modular chassis with a PowerEdge MX840c server and improve the performance of critical workloads', 'Making Postgres stored procedures 9X faster in Citus', 'How To: Protecting SQL Server on Clumio Using a Single-pass Backup', 'Deploying Dell EMC SRDF/Metro Smart DR with Microsoft SQL Server for Physical and Virtual Environments', 'PostgreSQL TPC-C Benchmarks: PostgreSQL 12 vs. PostgreSQL 13 Performance', 'Optimize Your Cloud With AMD and Microsoft Azure', 'vMotion Innovations in vSphere 7.0 U1', 'Intel Optimized Dell PowerEdge 4S Server for SQL Server 2019', 'vSAN Ready Nodes PowerEdge R740 QLT/OLAP', 'HammerDB : MS-SQL Server Workshop', 'Building a VMware Hybrid Cloud Platform', and 'Testing Intel Optane PMem Solution For SQL2019 In The ATC'.

Quick Anatomy of TPC-C

- Order Processing Use-case
- Typical Transactional use case
 - Simple SQL
 - Large in volume
- Two primary ‘knobs’ to size the effort
 - Warehouses – database size
 - User Concurrency
- **Resulting measure:** Transactions-per-minute (TPM)



Action Type	Mix
SELECT	75%
INSERT	8%
UPDATES	16%
DELETE	1%

LET'S START THE RACE



The effort at hand

- Evaluate the optimal mix of CPU, RAM, storage and network AND comparable DBaaS
- Use a defensible, standards-based workload that clients can also utilize in their own environment
- Run side-by-side benchmark
- Review the technical and economic result

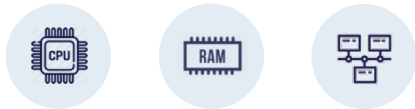


HammerDB





Example:
Amazon
brings a lot of
choices
 44 different
 choices with '8
 cores'



Purpose	Instance Name	CPU	RAM	EBS bandwidth	Network bandwidth	Storage	PER MONTH
General Purpose	a1.2xlarge	8	16		Up to 10	EBS Only	\$93.81
General Purpose	t4g.2xlarge	8	32	Up to 2,780	Up to 5 Gbps	EBS Only	\$123.08
General Purpose	c6g.2xlarge	8	16	Up to 4,750	Up to 10	EBS Only	\$125.12
General Purpose	t3a.2xlarge	8	32		Up to 5 Gbps	EBS Only	\$137.68
General Purpose	m6g.2xlarge	8	32	Up to 4,750	Up to 10	EBS Only	\$141.04
General Purpose	c6gd.2xlarge	8	16	Up to 4,750	Up to 10	1 x 474 NVMe SSD	\$141.25
General Purpose	c5a.2xlarge	8	16	Up to 3,170	Up to 10	EBS Only	\$141.62
General Purpose	t3.2xlarge	8	32		Up to 5 Gbps	EBS Only	\$152.28
General Purpose	c5.2xlarge	8	16	Up to 4,750	Up to 10	EBS Only	\$156.22
General Purpose	c6gn.2xlarge	8	16	Up to 9.5	Up to 25 Gbps	EBS Only	\$159.21
General Purpose	t2.2xlarge	8	32		Moderate	EBS Only	\$167.90
General Purpose	c5d.2xlarge	8	16	Up to 4,750	Up to 10	1 x 200 NVMe SSD	\$176.66
General Purpose	m5.2xlarge	8	32	Up to 4,750	up to 10Gbps	EBS Only	\$176.66
General Purpose	m4.2xlarge	8	32	1,000	High	EBS Only	\$180.89
General Purpose	c4.2xlarge	8	15	1,000	High	EBS Only	\$183.96
Memory Optimized	r6g.2xlarge	8	64	Up to 4,750	Up to 10	EBS Only	\$185.42
General Purpose	c5n.2xlarge	8	16	Up to 4,750	Up to 25 Gbps	EBS Only	\$198.56
Memory Optimized	r5a.2xlarge	8	64	Up to 2,880	Up to 10	EBS Only	\$208.05
General Purpose	m5d.2xlarge	8	32	Up to 4,750	Up to 10Gbps	1 x 300 NVMe	\$208.05
Memory Optimized	r6gd.2xlarge	8	64	Up to 4,750	Up to 10	1 x 474 NVMe SSD	\$211.92
General Purpose	m5n.2xlarge	8	32	Up to 4,750	Up to 25 Gbps	EBS Only	\$219.00
Storage Optimized	h1.2xlarge	8	32		Up to 10 Gigabit	1 x 2,000GB HDD	\$232.14
Memory Optimized	r5.2xlarge	8	64	Up to 4,750	Up to 10 Gbps	EBS Only	\$232.14
Memory Optimized	r5ad.2xlarge	8	64	Up to 2,880	Up to 10	1 x 300 NVMe SSD	\$240.90
Memory Optimized	r4.2xlarge	8	61		Up to 10	EBS Only	\$245.28
General Purpose	m5dn.2xlarge	8	32	Up to 4,750	Up to 25 Gbps	1 x 300 NVMe	\$250.39
Memory Optimized	r5d.2xlarge	8	64	Up to 4,750	Up to 10 Gbps	1 x 300 NVMe	\$264.99
Accelerated Computing	inf1.2xlarge	8	16	Up to 4.75 Gbps	Up to 25 Gbps	EBS Only	\$268.64
Accelerated Computing	11.2xlarge	8	122		Up to 10	470 GB	\$268.64
Memory Optimized	r5n.2xlarge	8	64	Up to 4,750	Up to 25 Gbps	EBS Only	\$273.75
Memory Optimized	r5b.2xlarge	8	64	Up to 10,000	Up to 10	EBS Only	\$274.12
Memory Optimized	r5b.2xlarge	8	64	Up to 10,000	Up to 10 Gbps	EBS Only	\$274.12
General Purpose	m5zn.2xlarge	8	32	3,170	Up to 25 Gbps	EBS Only	\$303.83
Memory Optimized	r5dn.2xlarge	8	64	Up to 4,750	Up to 25 Gbps	1 x 300 NVMe	\$307.33
Storage Optimized	i3.2xlarge	8	61		Up to 10 Gbps	1 x 1,900 NVMe	\$312.44
Memory Optimized	z1d.2xlarge	8	64		Up to 10 Gigabit	1 x 300 NVMe SSD	\$342.27
Accelerated Computing	g4dn.2xlarge	8	32		Up to 25 Gbps	225 GB	\$346.02
Storage Optimized	i3en.2xlarge	8	64		Up to 25 Gbps	2 x 2,500 NVMe SSD	\$449.68
Storage Optimized	d3.2xlarge	8	64	1,700	Up to 15	6 x 2TB HDD	\$459.17
Storage Optimized	d2.2xlarge	8	61		High	6 x 2000 HDD	\$586.92
Memory Optimized	x1e.2xlarge	8	122	Dedicated 500 Mbps	Up to 10 Gbps	EBS + 120GB SSD	\$750.44
Accelerated Computing	p3.2xlarge	8	61	14 Gbps	Up to 25 Gbps	EBS Only	\$1,524.24
General Purpose	c5ad.2xlarge	8	16	Up to 3,170	Up to 10	1 x 300 NVMe SSD	??
Storage Optimized	d3en.2xlarge	8	32	1,700	Up to 25 Gbps	4 x 14TB HDD	??

93.81/
month



\$1,524.24/
month

The real abstract topic - STORAGE



Google Cloud



- No performance control
- Quoted for **600GB**

Type	MAX 'sustained' IOPS	MAX 'sustained' Throughput
Standard	Read: 450 Write: 900	Read: 72 MB/sec Write: 72 MB/sec
Balanced	Read: 3,600 Write: 3,600	Read: 72 MB/sec Write: 72 MB/sec
SSD	Read: 15,000 Write: 15,000	Read: 240 MB/sec Write: 240 MB/sec

https://cloud.google.com/compute/docs/disks/?&_ga=2.62767211.-658045011.1598996595#pdperformance

- All about which level and what you are willing to pay – **600GB sizing**

Type	MAX 'sustained' IOPS	MAX Throughput
Optimized HDD (st1)		MAX 147 MB/s max
General Purpose SSD (gp2)	3000	
General Purpose SSD (gp3)	3000	500 MB/sec
Provisioned IOPS SSD (io1)	MAX 30,000	
Provisioned IOPS SSD (io2)	MAX 64,000	

https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/ebs-volume-types.html?icmpid=docs_ec2_console

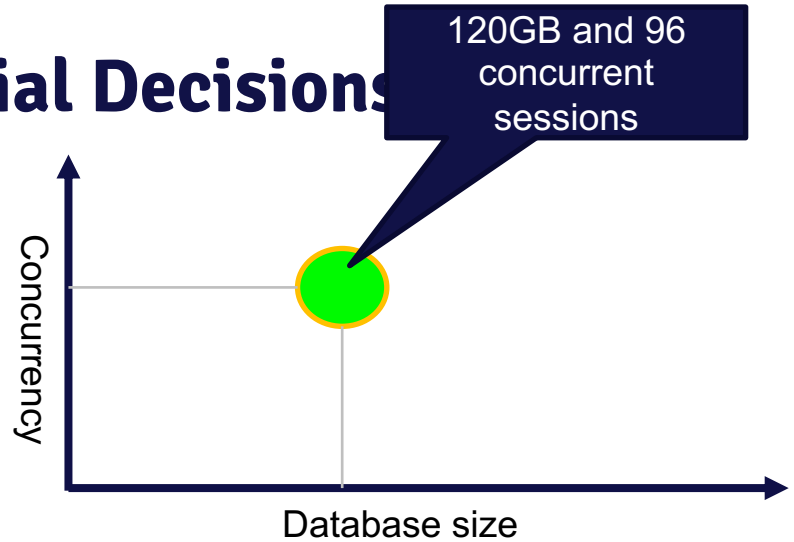
- Azure has 'binary' pricing = 128GB, 256, 512GB, etc.
- **Assume 1024 GB**
- *Performance limited by VM

Type	MAX 'sustained' IOPS	MAX Throughput
Standard HDD	500	60 MB/sec
Standard SSD	500	60 MB/sec
Premium SSD	5000	200 MB/sec
Ultra Disk	51,200*	768 MB/sec*

<https://docs.microsoft.com/en-us/azure/virtual-machines/disks-types>

NEXT STEP: Technical/Financial Decisions

- Two Dimensions – database size and concurrent sessions
- What virtual machines to use
- What storage to use and how to tune it (where possible)
- **NOTE:** Not all clouds offer the same CPU



aws	Google Cloud	Azure
3.2Ghz Intel	2.8 Ghz Intel	2.6Ghz Intel

Storage in the cloud – and price/performance



Example:
Microsoft Azure

$$((\# \text{ of GB} * \$0.15) + (\# \text{ of IOPS} * \$0.06) + (\# \text{ of MBps} * \$1.23)) * 12$$

- Top performing storage: **Ultra Disk**
- You pay for it in discrete increments: 256GB, 512GB, 1024GB, etc
 - i.e. Even if you want a volume of 300GB you pay for 512GB
- You configure:
 - IOPS = operations/sec
 - Throughput = MBps
- Each VM has published ‘limits’



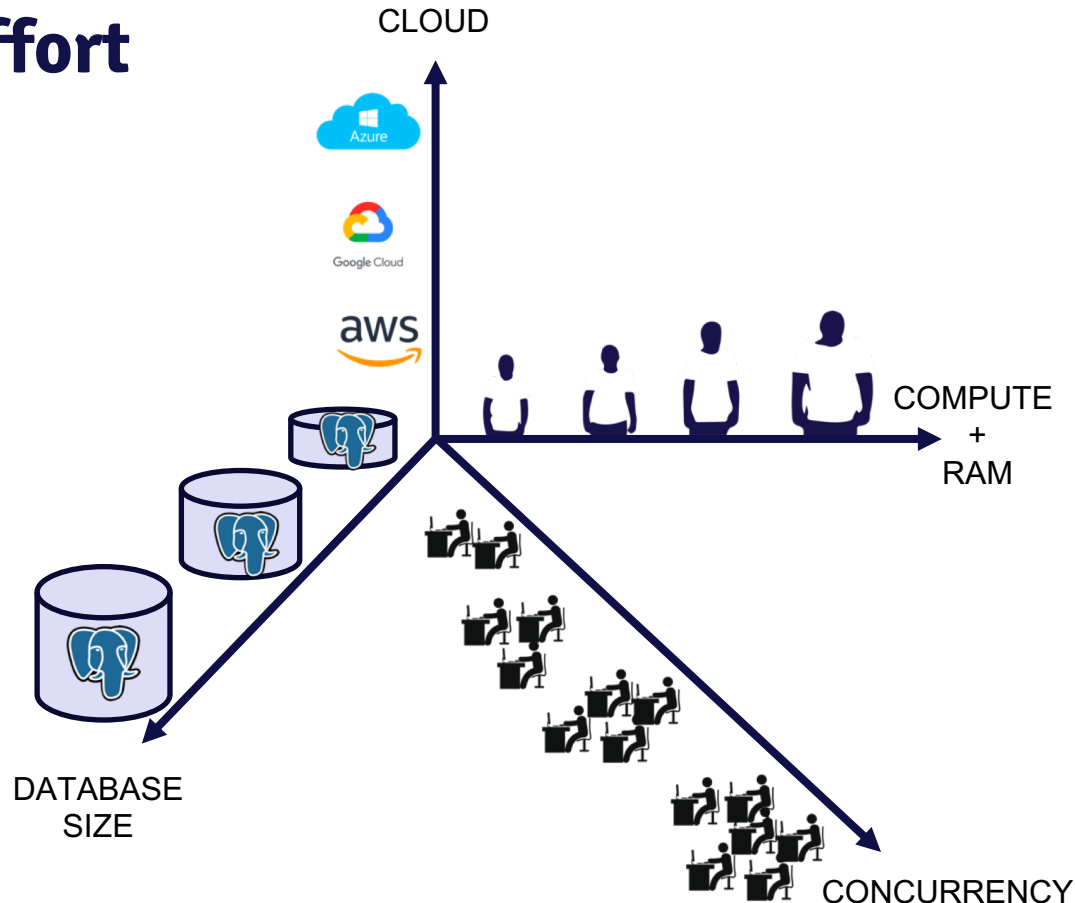
- Pricing
 - \$0.15/mon per GB
 - \$0.06/mon per IOPS
 - \$1.23/mon per MBps
- For our sizing efforts we used the following VMs:



Name	Size	“Max uncached disk throughput IOPS/MBps”
E4ds_v4	4 CPU/32 GB	6400/96
E8ds_v4	8 CPU/64 GB	12800/192
E16ds_v4	16 CPU/128 GB	25600/384
E32ds_v4	32 CPU/256 GB	51200/768

The dimensions of the effort

- HammerDB 3.3 running on its own 4-way server
- Ran over 370 separate benchmark runs across AWS, Azure and Google
- Generated over 34TBs of data/ across different sized instances
- Evaluated different storage, Postgres configurations and more



Storage in the cloud – and price/performance



Example:
Microsoft Azure

- MEDIUM T-Shirt
- 120GB database
- 96 concurrent sessions
- 5 minute 'warm-up' and 30 minute run
- Started with a fresh database each time
- ONLY VARIABLE CHANGE WAS DISK



IOPS	MBps	Result: TPM	Monthly Storage Cost	\$/TPM
35,000	2,000	303,163	\$9,378	\$0.42
20,000	1,000	293,734	\$5,071	\$0.26
15,000	750	285,979	\$3,841	\$0.21
12,800	500	293,383	\$2,954	\$0.17
12,800	200	288,399	\$2,214	\$0.14
10,000	200	286,854	\$1,870	\$0.13
9,000	100	285,301	\$1,624	\$0.12
7,000	100	292,939	\$1,256	\$0.10
6,000	80	287,503	\$1,084	\$0.09

Storage in the cloud – and price/performance



AWS EC2 and
lo2 disk

- MEDIUM T-Shirt
- 120GB database
- 96 concurrent sessions
- 5 minute ‘warm-up’ and 30 minute run
- Started with a fresh database each time
- **ONLY VARIABLE CHANGE WAS DISK PERFORMANCE!**

IOPS	Result: TPM	Monthly Storage Cost	\$/TPM
35,000	352,863	\$2,291	\$0.12
30,000	351,260	\$2,025	\$0.11
20,000	357,431	\$1,375	\$0.09
15,000	354,238	\$1,050	\$0.08
10,000	353,212	\$725	\$0.07
7,000	355,717	\$530	\$0.06
5,000	353,743	\$400	\$0.05
4,000	349,428	\$335	\$0.05
3,500	340,057	\$302	\$0.05
3,000	327,774	\$270	\$0.06

Other Observations - AWS

- 180 Postgres Conf parameters **cannot** be changed
- Two storage choices – slow and io1
- Limited in how often you can change the instance
- Death-by-monitoring tools – Cloud Watch, Performance Insights...\$\$\$\$



Modify DB instance: xl

Summary of modifications

You are about to submit the following modifications. Only values that will change are displayed. Carefully verify your changes and click Modify DB instance.

Attribute	Current value	New value
Allocated storage	600 GiB	600 GiB
Provisioned IOPS	7000	10000

Scheduling of modifications

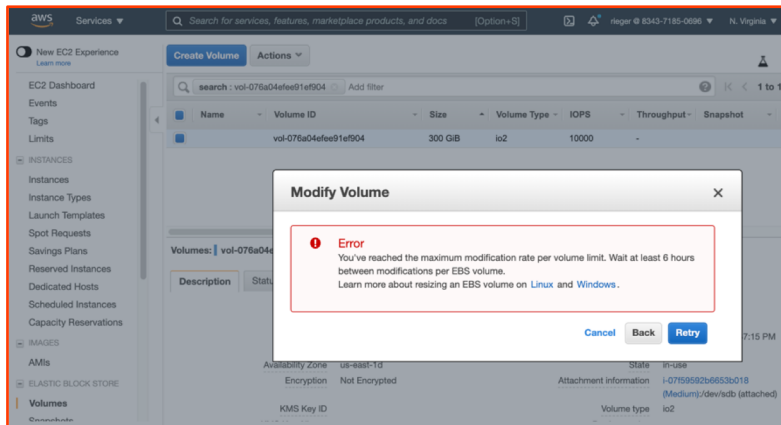
When to apply modifications

Apply during the next scheduled maintenance window
Current maintenance window: March 11, 2021 02:19 - 02:49 UTC-6

Apply immediately
The modifications in this request and any pending modifications will be asynchronously applied as soon as possible, regardless of the maintenance window setting for this database instance.

✘ We're sorry, your request to modify DB instance xl has failed.
You can't currently modify the storage of this DB instance. Try again after approximately 1 hours.

Cancel Back **Modify DB instance**



The screenshot shows the AWS Management Console interface. A 'Modify Volume' dialog box is open, displaying an error message:

Error
You've reached the maximum modification rate per volume limit. Wait at least 6 hours between modifications per EBS volume.
Learn more about resizing an EBS volume on [Linux](#) and [Windows](#).

Buttons: Cancel, Back, Retry

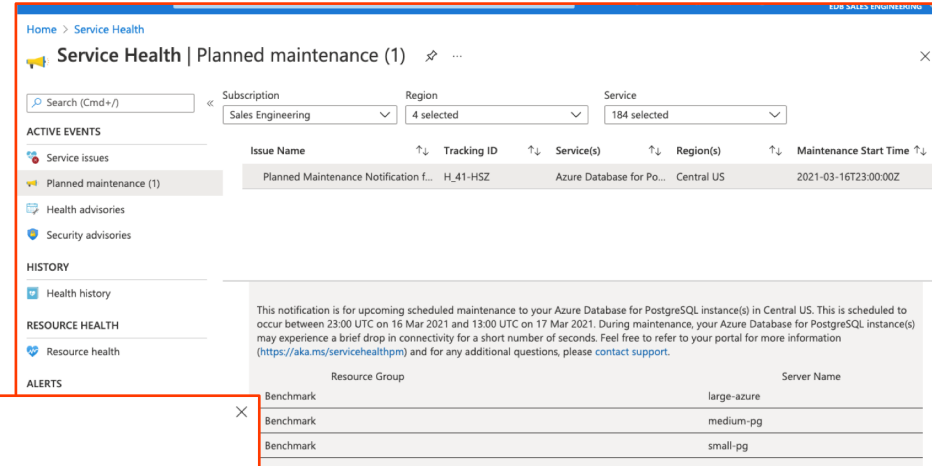
Provisioned IOPS SSD volumes can range in size from 4 GiB to 16 TiB. You can provision from 100 IOPS up to 64,000 IOPS per volume on [Instances built on the Nitro System](#) and up to 32,000 on other instances. The maximum ratio of provisioned IOPS to requested volume size (in GiB) is **50:1** for io1 volumes, and 500:1 for io2 volumes. For example, a 100 GiB io1 volume can be provisioned with up to 5,000 IOPS, while a 100 GiB io2 volume can be provisioned with up to 50,000 IOPS. On a supported instance type, the following volume sizes allow provisioning up to the 64,000 IOPS maximum:

- io1 volume 1,280 GiB in size or greater ($50 \times 1,280 \text{ GiB} = 64,000 \text{ IOPS}$)
- io2 volume 128 GiB in size or greater ($500 \times 128 \text{ GiB} = 64,000 \text{ IOPS}$)



Other Observations - Azure

- 155 Postgres Conf parameters **cannot** be changed
- **Single Server** is built on:
 - Old 7 year old Broadwell CPU
 - 3 IOPS/GB storage performance
 - Postgres 11.6
 - Built on Windows Server
- **Flexible Server** is built on:
 - Not sure – you don't get to choose
 - 4-5 IOPS/GB storage performance
 - Postgres 12.6
- **You can scale UP – but never BACK**



Home > Service Health

Service Health | Planned maintenance (1)

Search (Cmd+/) | Subscription: Sales Engineering | Region: 4 selected | Service: 184 selected

ACTIVE EVENTS

- Service issues
- Planned maintenance (1)
- Health advisories
- Security advisories

HISTORY

- Health history

RESOURCE HEALTH

- Resource health

ALERTS

Issue Name	Tracking ID	Service(s)	Region(s)	Maintenance Start Time
Planned Maintenance Notification f...	H_41-HSZ	Azure Database for Po...	Central US	2021-03-16T23:00:00Z

This notification is for upcoming scheduled maintenance to your Azure Database for PostgreSQL instance(s) in Central US. This is scheduled to occur between 23:00 UTC on 16 Mar 2021 and 13:00 UTC on 17 Mar 2021. During maintenance, your Azure Database for PostgreSQL instance(s) may experience a brief drop in connectivity for a short number of seconds. Feel free to refer to your portal for more information (<https://aka.ms/servicehealthpm>) and for any additional questions, please [contact support](#).

Resource Group	Server Name
Benchmark	large-azure
Benchmark	medium-pg
Benchmark	small-pg

Errors

Summary | Raw Error

```

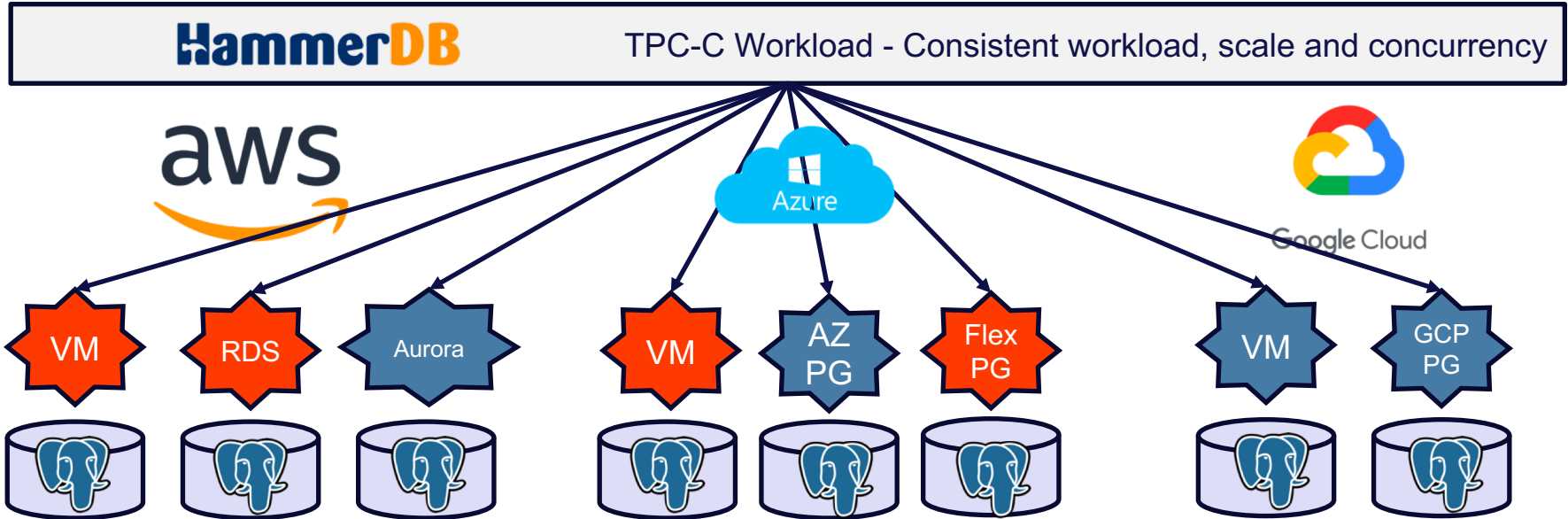
1  {
2    "code": "DeploymentFailed",
3    "message": "At least one resource deployment operation
4    failed. Please list deployment operations for details. Please
5    see https://aka.ms/DeployOperations for usage details.",
6    "details": [
7      {
8        "code": "ZonalAllocationFailed",
9        "message": "Allocation failed. We do not have sufficient
10       capacity for the requested VM size in this zone. Read more
11       about improving likelihood of allocation success at http://
12       aka.ms/allocation-guidance"
13     }
14   ]
15 }

```

LET US CHECK ON THE RACE



Multi-Cloud Sizing and Benchmarking – to help you decide



Deliverables to you

Make it all more predictable and prescriptive



“How to” –
Legacy workload
evaluation
documents and
reproducible scripts



“eBook” - Best practices
around cloud setup and
database configuration



GitHub Scripts

- To allow you to execute your own ‘race’ and sizing effort.



Calclator - Financial
business case formulas
and documents to help
speak in ‘debit/credit’
lexicon

Key Takeaways

- It is difficult to technically compare cloud database offerings – but cost-per-transaction is the most important measure.
- Most enterprises inadvertently over-provision and over-pay for Postgres in the cloud. Consider the storage examples.
- Some cloud offerings restrict your flexibility to tune, configure and optimize based on your unique workloads.
- Some DBaaS offerings are built on obsolete hardware and older releases of Postgres
- Let us know if you want to have a specific conversation by cloud and need
- **MORE TO COME!!**



What you can expect after the webinar

An email from me with.....

- Access to a recording of this webinar
- Access to the slides presented today
- Where you can find the Github library which include repeatable scripts
- Fundamental HammerDB how-to guide to try this yourself
- Answer any questions

EDB portfolio

SOFTWARE

PostgreSQL

EDB Postgres Extended

EDB Postgres Advanced

Open Source Tools *

EDB Postgres Tools **

SUPPORT

PostgreSQL
Technical Support

Cloud DBA Service

Remote DBA Service

Technical Account Manager

SERVICES

Getting Started

Postgres Optimization

Enterprise Strategy

Custom Services

Training

* OmniDB, pgBarman, repMgr, PostGIS, Pgpool, PgBouncer, pgAdmin, Foreign Data Wrappers

** Postgres Enterprise Manager, Backup and Recovery Tool, Failover Manager, Migration Toolkit, Replication Server, BDR, Kubernetes Operators, Connectors

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JUNE 22 - 23

postgresvision.com

The Future is Postgres



Global event



2 full days



Multiple tracks



PostgreSQL experts and customers



Interaction with colleagues



PostgreSQL community connection

In closing



Questions

Please make sure if you have questions to type them into the tool



Exit survey

There is an exit survey that will pop up – please tell us your thoughts on this webinar



Contact us

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