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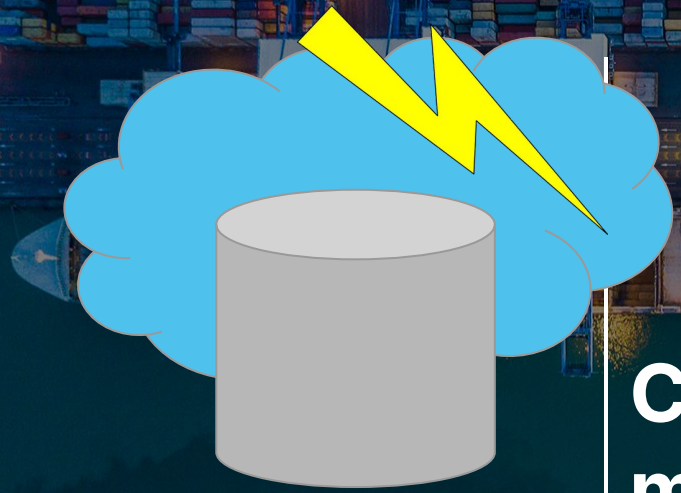

Cloudy database management - no problems at all?

Kaarel Moppel, Cognite

PGUG.EE January 2023 meetup

Meet the presenter

- Full-time “fighting” with databases for the last 15 years
- Since 2011 with Postgres, with 5 years of that as a consultant
  - Thus I've gotten a pretty unique insight into architectural / tooling decisions of dozens of companies and have a pretty good understanding of what works reasonably well and what not
- Principal DBRE at Cognite where we build an Industrial DataOps product with all the modern buzzwords covered (AI, Digital twins, Knowledge graphs, ...)
  - Currently we have around 300 primary instances of Postgres + hundreds of other non-relational instances (FoundationDB, Kafka, Elastic)

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Agenda

- Managed databases overview, pros and cons
- Typical DB-related DevOps tooling
- Newer trends

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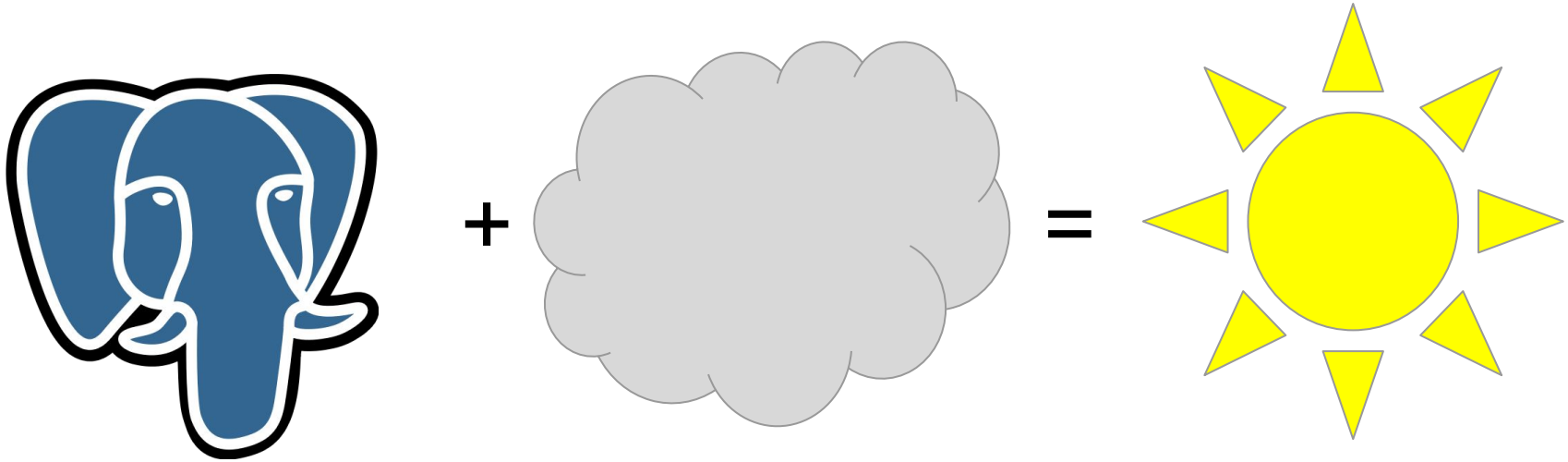
Managed Databases high-level overview

Relational database = Postgres of course ;)

In short - should be your default choice for all relational storage needs, where one doesn't need to scale like crazy

- And I mean "crazy", as Postgres has quite some tricks up its sleeve



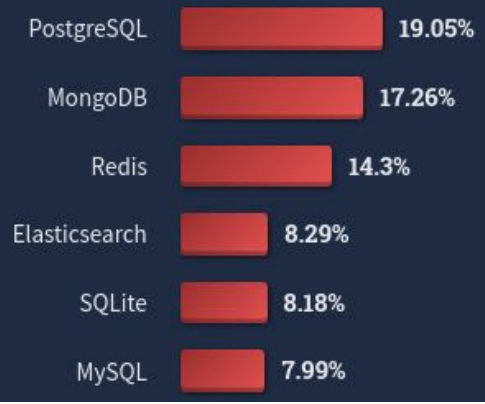
survey.stackoverflow.co/2022/#most-loved-dreaded-and-wanted-database-want

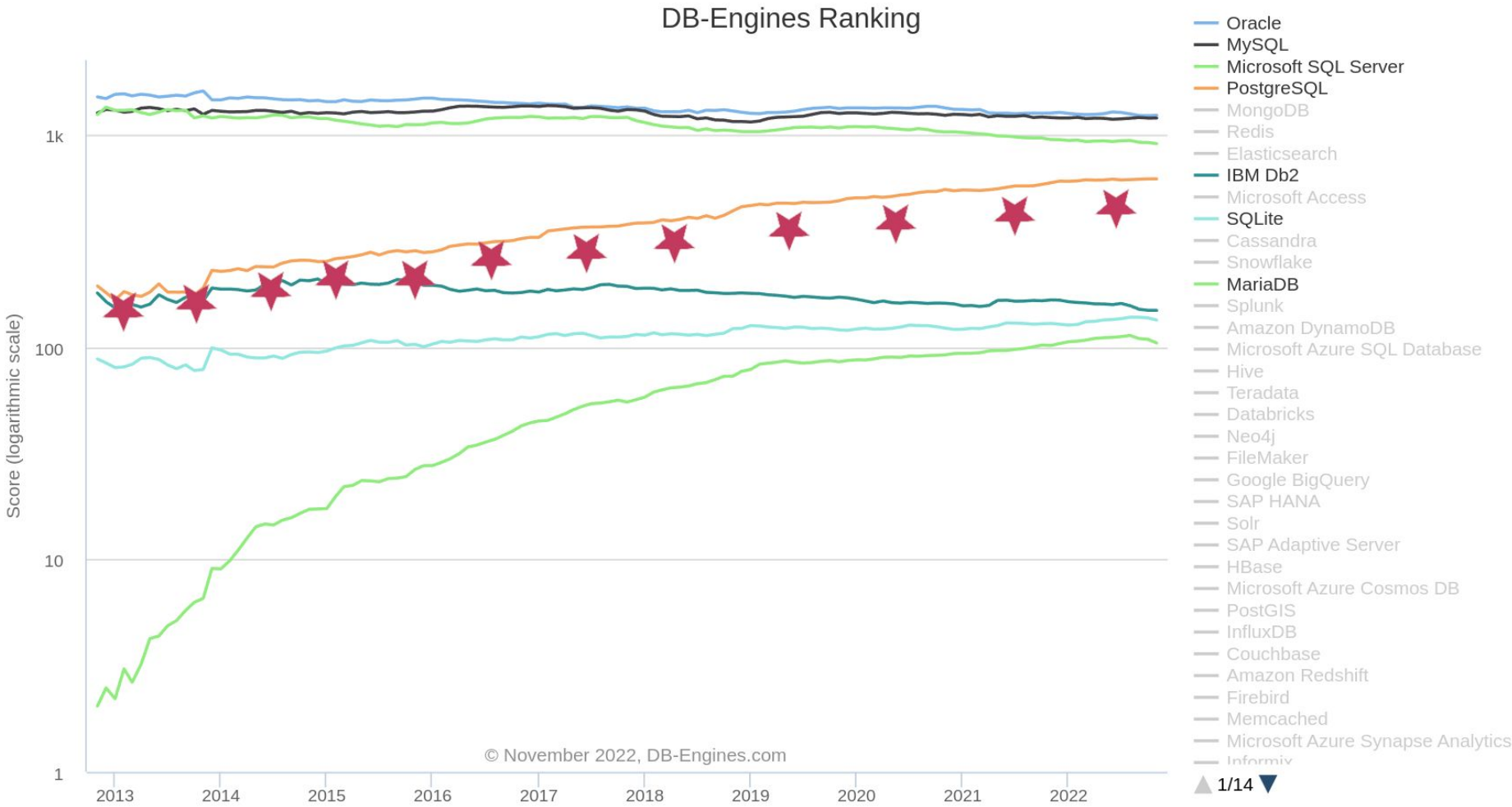
Databases

PostgreSQL becomes the most loved and wanted database after five years of Redis being the most loved.

Loved vs. Dreaded | Want

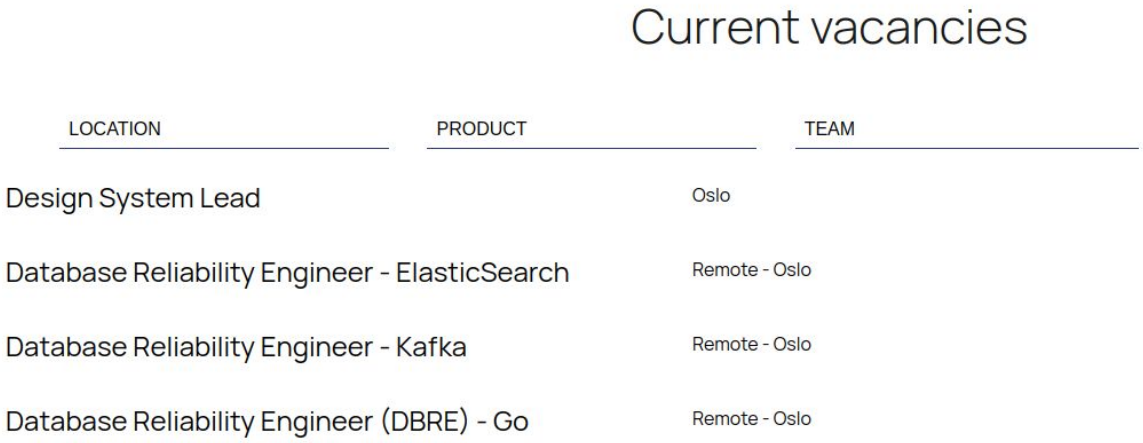
62,594 responses
% of developers who are not developing with the language or technology but have expressed interest in developing with it




DB-Engines Ranking
Score (logarithmic scale)
1k
100
10
1
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
© November 2022, DB-Engines.com
Oracle
MySQL
Microsoft SQL Server
PostgreSQL
MongoDB
Redis
Elasticsearch
IBM Db2
Microsoft Access
SQLite
Cassandra
Snowflake
MariaDB
Splunk
Amazon DynamoDB
Microsoft Azure SQL Database
Hive
Teradata
Databricks
Neo4j
FileMaker
Google BigQuery
SAP HANA
Solr
SAP Adaptive Server
HBase
Microsoft Azure Cosmos DB
PostGIS
InfluxDB
Couchbase
Amazon Redshift
Firebird
Memcached
Microsoft Azure Synapse Analytics
Informix
1/14

So…welcome to the managed Cloud!

- No way around managed databases for scale-ups
  - They do solve many problems for us to focus on other things
  - Very difficult to hire DB engineers



Managed DB infrastructure PROS

- Well, don’t have to think about DB infrastructure anymore - it becomes a guaranteed service with a SLA!
- Some things become really hard to screw up
  - The initial provisioning part - a one-liner on the CLI basically
  - High-Availability / automatic failover is another “checkbox”
  - Backups
  - Most essential tuning flags set to match the SKU
    - Workload agnostic still(*)
- Can scale easily if to throw $$ at the problem
  - Not talking only about standard SKU++ here - there also some quite high-performance wire-compatible derivatives available (the likes of Azure Cosmos DB, AlloyDB, Aurora)
- Don’t need to know any engine internals (initially), can just jump to SQL / business logic!

* AlloyDB brings something to the table here

Managed DB infrastructure CONS

- $$ - easily 2-3x the cost of plain VMs with database self-installed (*)
  - Even more if to add HA (*)
  - Some obnoxious cloud providers don’t even lay out the price for you in the UI
  - Extra sad fact of the matter - developers generally have no good understanding of future performance needs (especially if using some ORM-s etc, so that test benchmarking is hard) and thus commonly just over-provision
  - On some clouds there are some ways to reduce costs a bit though (VM suspend, auto-scaling based on load) if load is not constant
- Very slow or “just” slow disk access for low / medium tier SKUs
  - IOPS tied to SKU size and / or volume size in most cases
  - Some clouds provide guaranteed IOPS for $++ as a remedy
- Debugging is super hard, if it should come down to that (and it eventually will*)
  - Some clouds are clearly better than others when it comes to contacting the “helpdesk”

DB domain specifics - well SOLVED themes

- Point-in-Time and normal Disaster Recovery (*)
- AD / IAM authentication and authorization integration
  - Both for control and SQL plane
  - VPC only SQL access option
- Auto-updates to minor versions
- Alerting integration (on some clouds)
- Auditing for most important instance lifecycle actions

DB domain specifics – partially or NOT SOLVED themes

- Lacking metrics - very basic / generic insight on DB internals on most clouds
  - Need to roll your own custom layer still for larger organizations
  - Sometimes just to solve the access problem i.e. to make metrics public
- Provider side config tuning at very basic level
  - Need engine-specific knowledge
  - A lot of settings even can’t be set for no good reason (*)
- Basic perf problem detection / solving (Top X slowest SQL mostly)
  - For background processes etc still need to have someone with engine knowledge
- Major version upgrades require manual attention
  - And they take a lot more downtime than necessary, compared to "on-prem"
- Access security management lacking mostly
  - Only few clouds support client certificates
  - Looking at HBA rules leaves you guessing most of the time
  - Brute-force protection not activated on most clouds, even if world open 🤯

DB domain specifics - partially or NOT SOLVED themes

- For Postgres - very limited selection of “extensions” are allowed
  - From “super-extensions” PostGIS is the only one universally supported
  - TimescaleDB only on few and lagging in versions
- Instance lifecycle events tracking suffers often from “selective memory”
- Restrictive server log search and long term archival options (*)
  - Logging options (log_line_prefix) not tunable at all on most clouds
- In addition to operator configuration / tuning mistakes, providers also take “interesting” defaults sometimes (like synchronous_commit=off)
- Obviously no 100% guarantees also against provider side mishaps / downtimes. Some problems we’ve faced during last 1.5yrs:
  - Collations FU on minor update
  - Subnet IP caching / depletion
  - Too active API saturation / throttling
  - Storage auto-scale fragmentation penalty
  - + some more …

Another “problem” - Wow, so many clouds…

- Which to take?
  - Well, generally the one which you're already using…
  - Up to 50% perf differences on comparable SKUs
- What if you’re going multi-cloud?
  - Many simple things become problematic now…there are always differences not only in API but also concepts / naming
  - Given you're on the same Cloud + Region, could also use meta-providers!
    - Like aiven.io e.g.
    - Get nicer API / UX usually
- Postgres or Postgres-compatible? Or Serverless?
  - Aurora
  - Neon
  - bit.io

DevOps and Cloud DBs

DevOps - DB-related tooling needs

Handling the most essential DB lifecycle events like initial provisioning

- Lots of choice
- A few no-brainers like Terraform and Ansible

Larger shops will often discover though that there are lot more DB-specific tasks to handle / automate in a repeatable manner:

- Tools for evolving the DB schema in a VC way
  - Flyway, Liquibase, …
- DB clones for cheap feature testing / development
- Cloning prod data to staging with anonymization / obfuscation
- Unified metrics / logging analysing experience
- Regular failover, DR and chaos-testing
- Automated data lineage tracking
- Postgres specific maintenance (bloat reduction, reindexing)
- …

DevOps tooling - Terraform

The most common tool for essential DB-lifecycle management

PROS

- A very popular choice for Cloud in general
  - Thus a relatively safe bet also for DB management
- Good development / rollout tooling support
- Top tier DB modules maintained by cloud provider directly or use some code generation from API specs
  - i.e. relatively short delays to support new cloud features / APIs
  - Can just look at the Cloud provider API documentation for available attribute values etc

DevOps tooling - Terraform

CONS

- Lacking imperative actions and full Postgres lifecycle support
- Copy-Paste templates can / will become a problem for hundreds of instances
  - Some unnecessary stuff will start to make rounds
- Some danger of “versioning hell” - hard to evolve root modules without cryptic errors / manual state-file modifications for already running stuff
  - Results in outdated settings for most already provisioned instances
  - Note that it’s even debatable if it’s a good idea to “backfill” e.g. apply new tuning settings
- Not a state machine per se, configuration drift can occur on manual overrides
  - Due to incident handling mostly - needs discipline from DevOps / Incident teams!

So in short - take existing tooling as "something", but be open to mix & match, and prepared for going "manual" for certain actions still

Terraform at Cognite

How it's used at Cognite in DB space

- "Root" module and a sample “intermediary” module maintained by DB engineers, project “intermediary” and rollout modules by teams
  - Root - best practice tuning, backup, HA settings + some company specifics, e.g. store logins in a certain space, monitoring, schema default privileges
  - Intermediary modules - project specific changes + naming / tag changes
  - Rollout modules - mostly a clone stamp from “intermediary” for some env X
- Devs copy-paste and replace, create a PR, get initial "plan" errors if any
  - Relying on Atlantis here
- Gets peer / DBRE reviewed depending on project, devs roll out
  - Some transient errors are possible still, re-plan / re-apply first

Things that can't be automated / DevOps-ed away

Sad fact of life - the bigger you scale, the less an average dev knows / sees / cares about databases. Some remedies:

- Documentation for devs - just the right amount, and not too tribal
- Take as many "sane default" decisions as possible as a technology expert
- Knowledge sharing
  - These topics can be “looped” eternally basically as new devs onboard
    - Effective indexing
    - Partitioning
    - Testing your queries properly (*)
      - Testdata generation + EXPLAIN ANALYZE
  - A “Postgres guild” with monthly presentations to tackle that at Cognite
- “One size fits” alerting thresholds generally won’t work - must be easily configurable, team-driven and owned

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Next level of DevOps

Next level of DevOps = no “Ops” at all, just “Dev” :)

- Meaning “~~Turtles~~ K8s all the way down”
  - Abstracting away the infrastructure
  - Well, for developers at least
- Apps getting deployed in a fully declarative, platform-agnostic way, including the databases!
- That model doesn’t match well though with managed databases, because they’re still external to K8s.
- Need to choose:
  - Install / run DBs directly in K8s in a semi-managed way
  - Or intermediate somehow between K8s and the Cloud

Semi-managed Postgres on K8s

- Should be only used for some specific needs(*) or for those who want more control over all tuning setting or need a true “superuser”
  - Doesn’t guarantee any automatic performance improvement, especially on managed K8s
  - Good for saving some $$ though
- Need to choose an operator - for Postgres:
  - https://github.com/CrunchyData/postgres-operator 3K (Github stars)
  - https://github.com/zalando/postgres-operator 2.9K
  - https://github.com/cloudnative-pg/cloudnative-pg <1K
  - https://github.com/ongres/stackgres <1K
  - https://github.com/percona/percona-postgresql-operator <1K
  - …
- NB! You’re now basically on your own with non-standard events!
  - Consider getting also some support contract for (possible) problems

K8s intermediated managed Postgres

- Need to choose some “operator of external resources” layer
  - We experimented with Crossplane, but didn't work out for us
    - There are a few others like movetokube/postgres-operator
  - All clouds will start to look the same:

```
---
apiVersion: database.example.org/v1alpha1
kind: PostgreSQLInstance
metadata:
  name: my-db
  namespace: default
spec:
  parameters:
    storageGB: 20
  compositionSelector:
    matchLabels:
      provider: gcp
  writeConnectionSecretToRef:
    name: db-conn
```

Another alternative - build your own IDP!

- Internal Developer Platforms (IDP) are all the rage nowadays
  - A “self-service”, API or some configuration language (K8s CRD-s) that already knows about your environment and aims to simplify **developer friction basically to zero**
  - Not possible to simplify 100% of requirements of course, aim for Pareto / golden path
- That’s what we at Cognite actually see as a long-term solution and are building one
  - Not a particularly easy or cheap undertaking though - be warned :)
  - A K8s Custom Resource looks something like that then:

```
apiVersion: infra.cognite.ai/v1alpha1
kind: CdfService
metadata:
  name: kaarel-test-db1
  namespace: app-1
  labels:
    team: devtooling
spec:
  postgresdb:
    enabled: true
```

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Wrap-up

Key takeaways

- Managed databases are not a silver bullet by far - solves just a part of the equation

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- Managed databases are not a silver bullet by far - solves just the infrastructure part of the equation
- Large organizations will hit some limitations of managed services sooner or later - test (performance) thoroughly and have a backup plan in place
  - For example test how to migrate off your chosen cloud provider or product - some providers make it harder than necessary

Key takeaways

- Managed databases are not a silver bullet by far - solves just a part of the equation
- Large organizations will hit some limitations of managed services sooner or later - test (performance) thoroughly and have a backup plan in place
  - For example test how to migrate off your chosen cloud provider or product - some providers make it harder than necessary
- Most popular DevOps tools “per design” don’t cover the whole lifecycle
  - Forget the idea of a "single tool to rule em' all" as you get bigger
  - Need to combine a few and be prepared to go "manual" for certain actions
  - A custom control-plane / IDP can be a better solution

Key takeaways

- Managed databases are not a silver bullet by far - solves just a part of the equation
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  - For example test how to migrate off your chosen cloud provider or product - some providers make it harder than necessary
- Most popular DevOps tools “per design” don’t cover the whole lifecycle
  - Forget the idea of a "single tool to rule em' all" as you get bigger
  - Need to combine a few and be prepared to go "manual" for certain actions
  - A custom control-plane / IDP can be a better solution
- Need to have a few competent people onboard still - we’re not as far yet as one might think with managed DB offerings and DevOps tooling
  - As databases really are inherently special with their “annoying” lifecycle and service criticality

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THANK YOU