How we migrated 7'000 client PostgreSQL databases

Silicon Chalet, 16.10.2024

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Software Engineer

Head of Infrastructure at DIVIO

@derlin

https://derlin.ch

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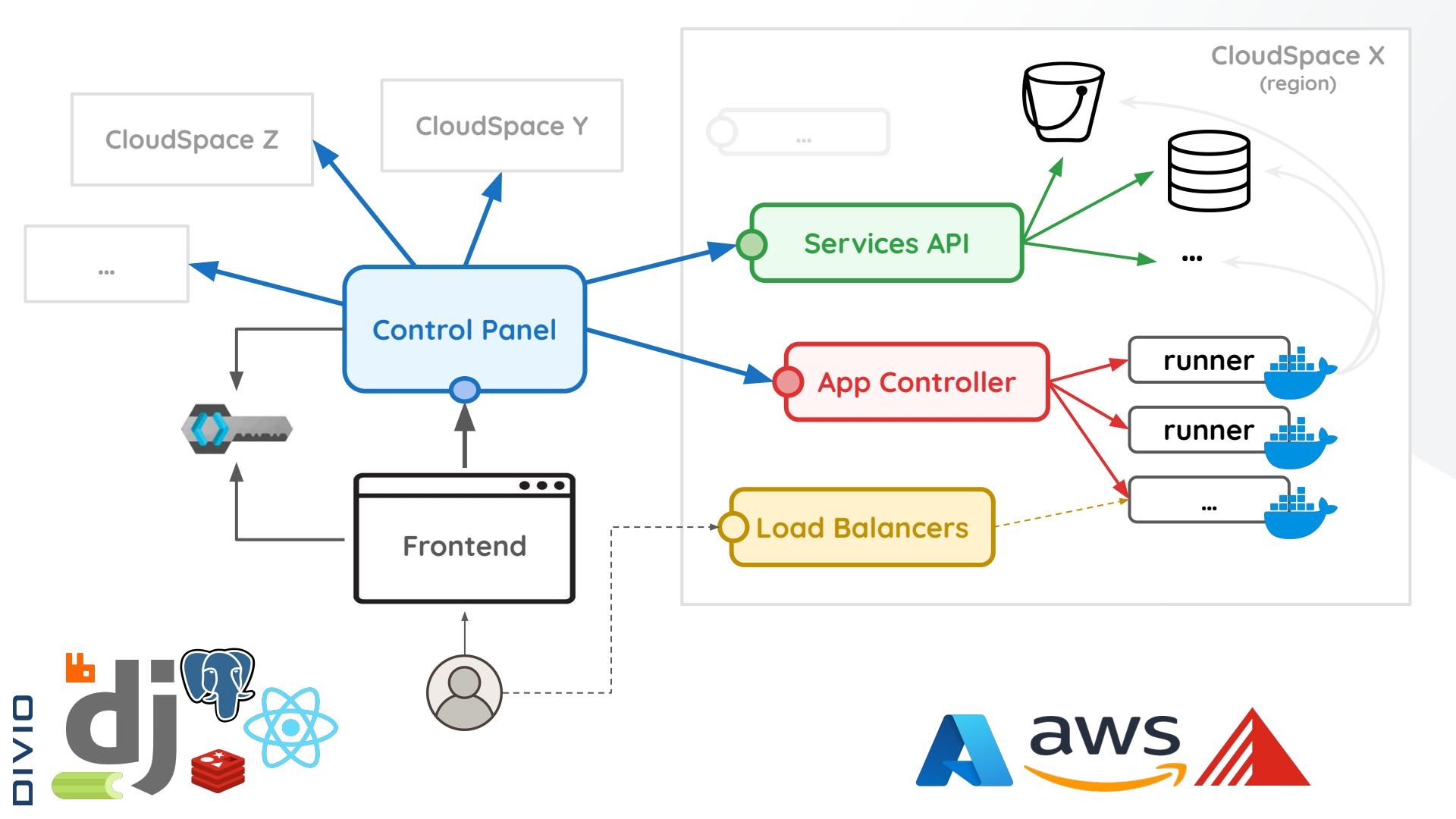
PaaS

"Peace of mind"


CloudSpace Z
CloudSpace Y
...
Control Panel
Frontend
CloudSpace X
(region)
...
Services API
...
App Controller
runner
runner
...
Load Balancers
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5 + X
regions

7'000+
applications

8 engineers

10'000+
environments

25'000+
services

7'326
postgres 13

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Back to Postgres

PostgreSQL 13
24.09.2020

PostgreSQL 15
12.10.2022

FROM: Amazon Web Services, Inc.
ON: June 11, 2024

[Action required] Update Your Amazon RDS and Amazon Aurora SSL/TLS Certificates by August 22, 2024

...

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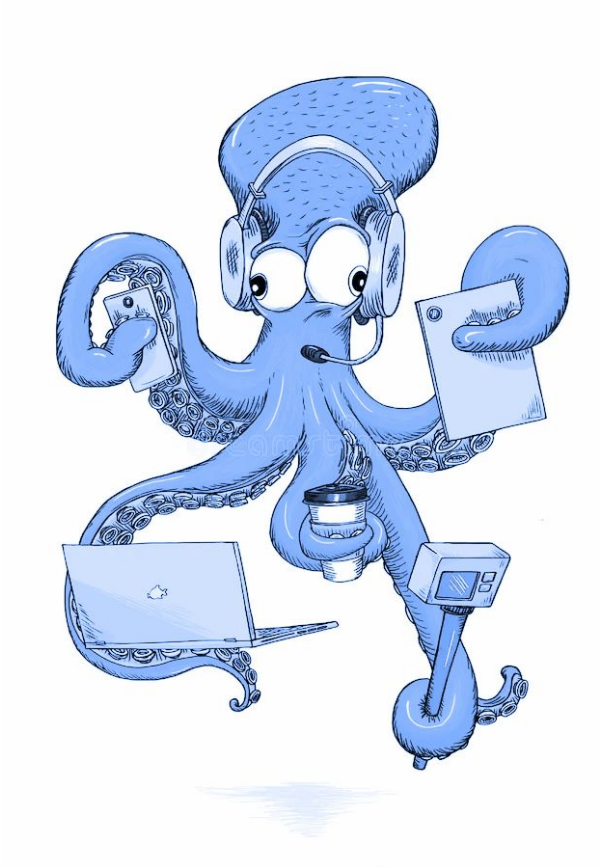

"good"
design

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I. codebase

II. dependencies

III. config

IV. backing services

V. build|release|run

VI. processes

The Twelve-Factor App

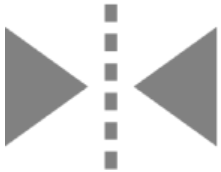
https://12factor.net

VII. port binding

VIII. concurrency

IX. disposability

X. logs



XI. dev/prod parity

XII. admin processes

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III. config

Store config in the environment

A Divio App is ...

1. Dockerized code
2. Running in stateless containers
3. Connected to backing services
4. Configured via Environment variables
5. And disposable (scalable!)

VI. processes

Execute the app as one or more stateless processes

IV. backing services

Treat backing services as attached resources

VIII. Concurrency

Scale out via the process model

IX. disposability

Maximize robustness with fast startup and graceful shutdown

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V. build|release|run

Strictly separate stages

1 (BUILD)
`docker build -t bld0 …`

```
FROM ...
...
```

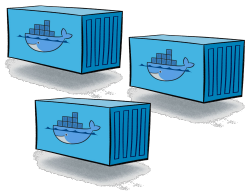
```
.
├── Dockerfile
├── index.html
├── ...
└── src
```

2 RELEASE
`docker build -t rel0 …`

```
FROM bld0

ENV X_DATABASE_DSN=postgres://user:pass@host/dbname
ENV FOO=bar
ENV ...
```

3 RUN
`docker run rel0`



sanity checks

stop old release

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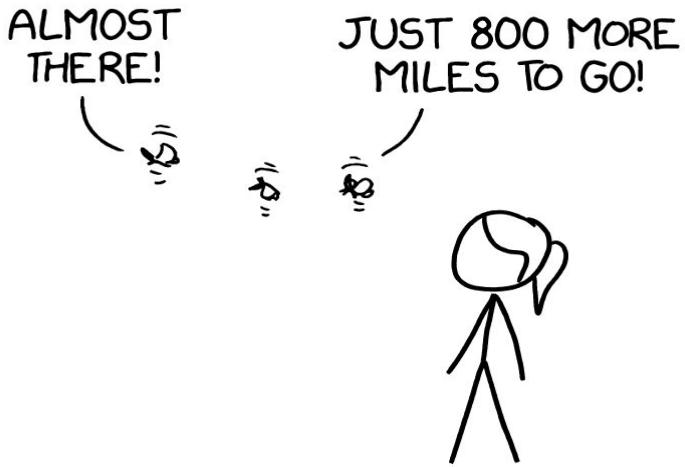
Basic Migration Process

- Create NEW
- Stop writes
- Backup OLD (`pg_dump`)
- Restore to NEW (`pg_restore`)
- Update app
- Resume writes
- Delete OLD



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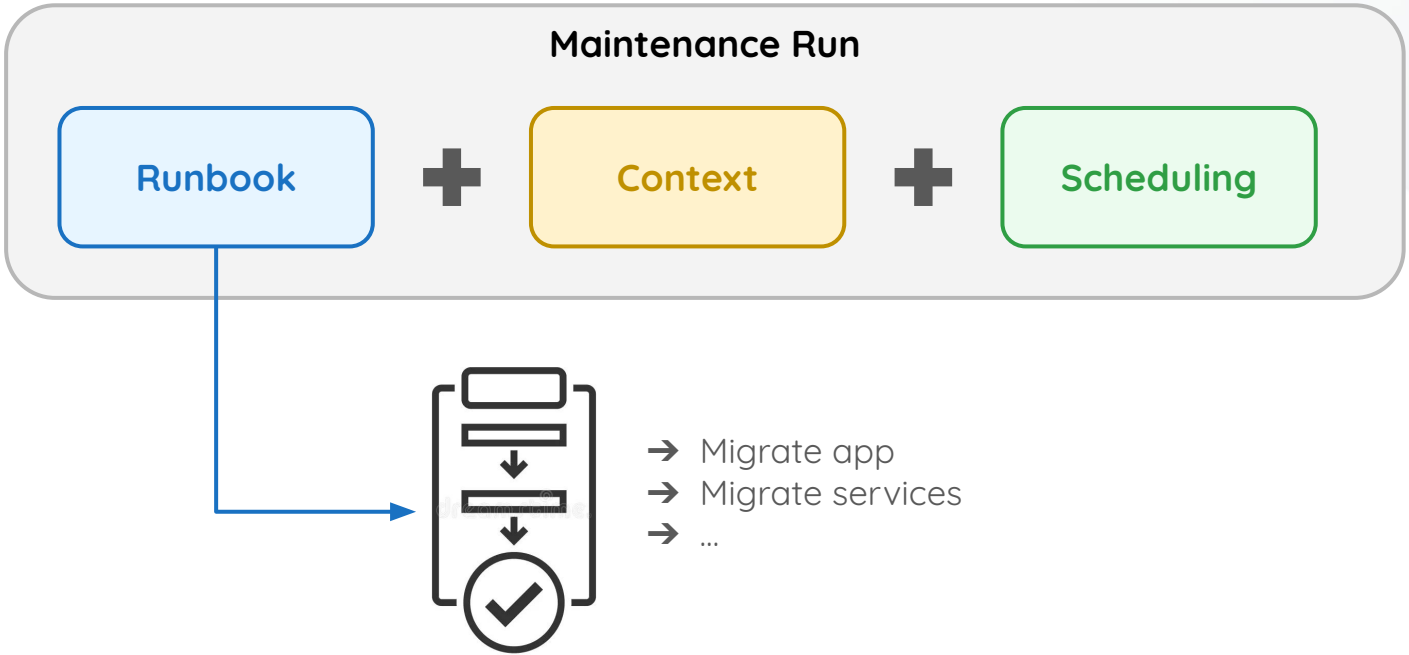
What's a maintenance?



XII. admin processes

Run admin/management tasks as one-off processes

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base class

```
class Runbook:
  preconditions = None
  operations = None

  def estimated_execution_time(self, run):
    # return a maintenance duration

  def apply(self, run):
    # apply maintenance on each context
```

limit to pg13 apps

```
class PostgresRunbook(runbook.Runbook):
  preconditions = [
      conditions.HasServiceInstance(
          service_identifier="postgresql-database-13",
          provisioned=True,
      )
  ]
  operations = [
      ...
  ]
```

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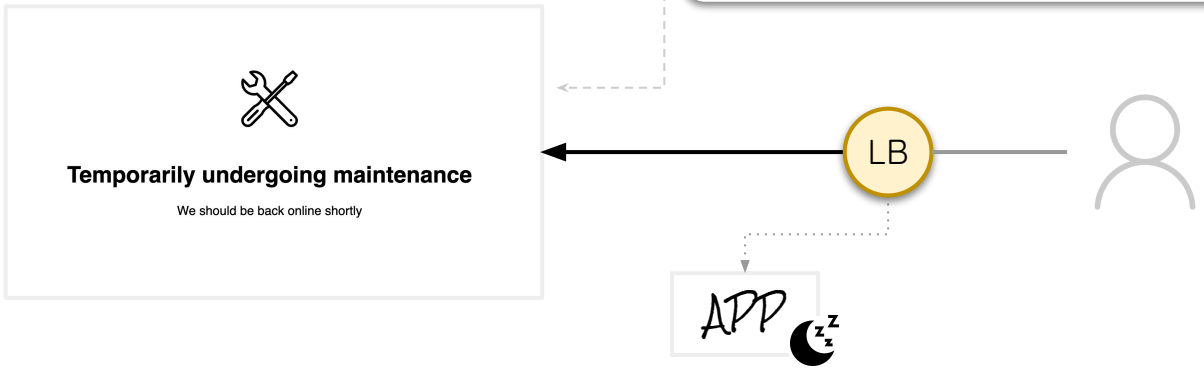
provision

```
operations.CollectServiceInstances(
  service_identifier="postgresql-database-13",
  provisioned=True,
),

operations.ReprovisionCollectedServiceInstances(
  service_identifier_overrides={
      "postgresql-database-13": "postgresql-database-15"
  },
  copy_runtime_options=True,
),
```

pause the app

```
operations.WithMaintenancePage(
  pause=True,
  maintenance_app_pk=settings.MAINTENANCE_APP_ID,
  operations=[
    ...
  ],
), # will unpause after the operations
```



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switch database

```
operations.BackupCollectedServices(
  notes=(
      "Backup taken prior to the migration of the database"
      " from Postgres 13 to Postgres 15."
  ),
),
operations.RestoreBackupToReprovisionedServices(),
operations.EnableReprovisionedServices(),
```

Available in the backups tab :)

redeploy

```
operations.ConditionalOperation(
  when=[conditions.Deployed()],
  then=[
      operations.Deploy(
          adopt=True,
          run_release_commands=False,
          allow_failure=False,
      )
  ],
),
```

no re-build, re-release only

unpause

WithMaintenancePage

cleanup

```
operations.DeprovisionCollectedServiceInstances(),
```

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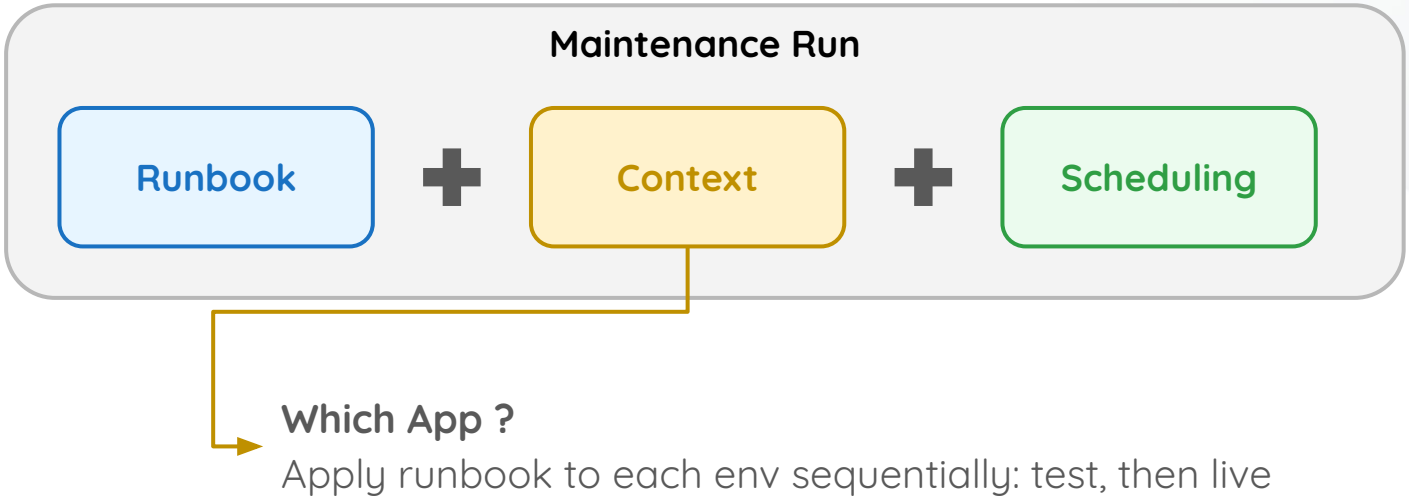

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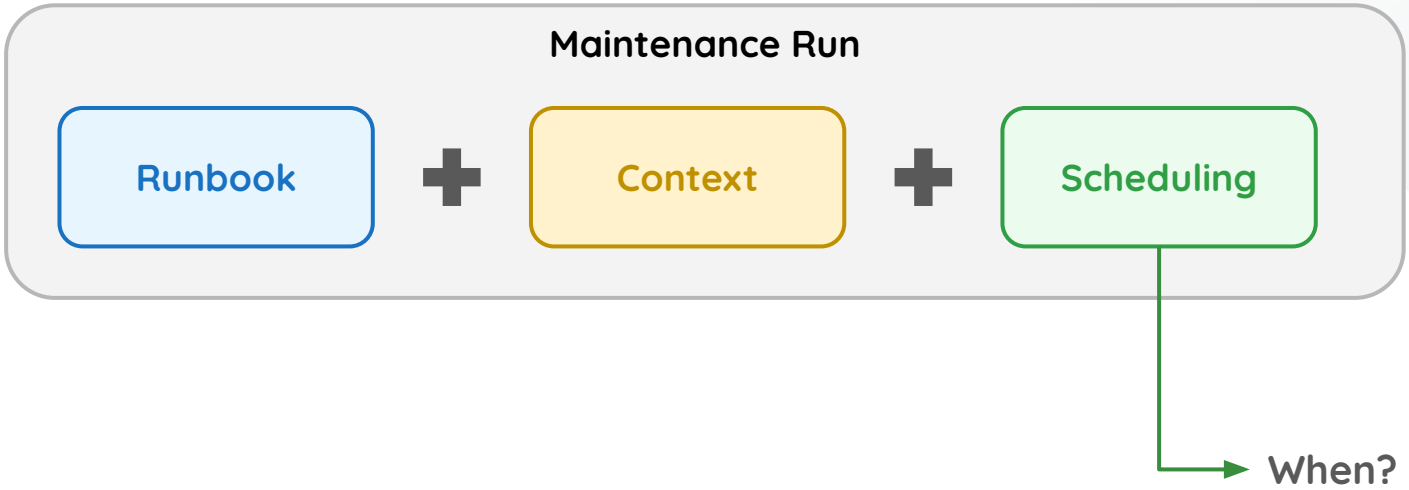
XII. admin processes

Run admin/management tasks as one-off processes



XII. admin processes

Run admin/management tasks as one-off processes

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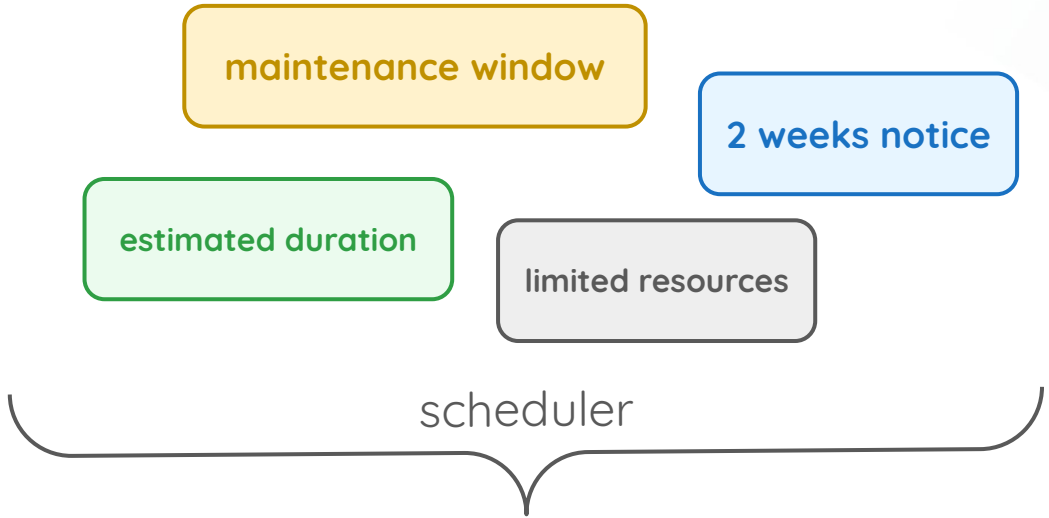
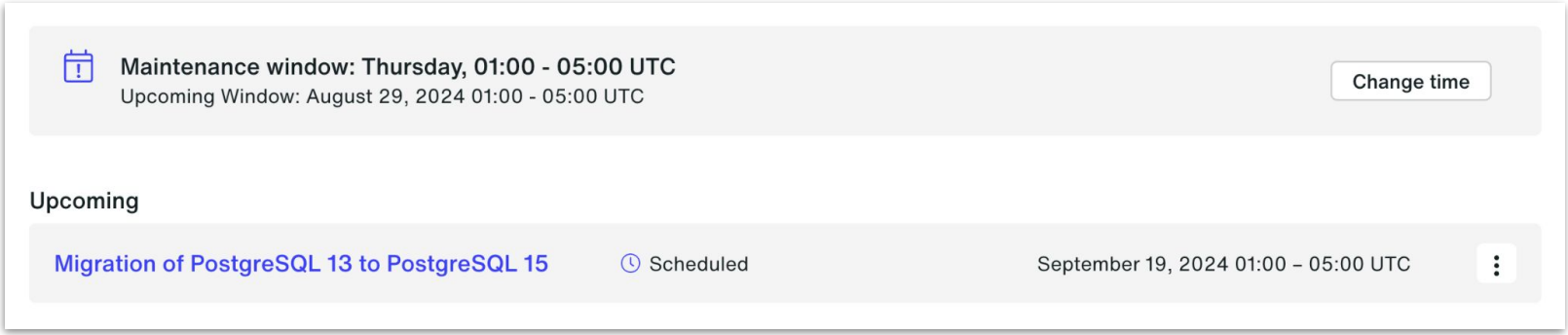

maintenance window
2 weeks notice
estimated duration
limited resources
scheduler


Maintenance window: Thursday, 01:00 - 05:00 UTC
Upcoming Window: August 29, 2024 01:00 - 05:00 UTC
Change time
Upcoming
Migration of PostgreSQL 13 to PostgreSQL 15
Scheduled
September 19, 2024 01:00 – 05:00 UTC

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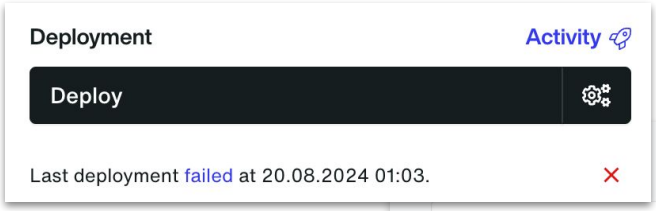
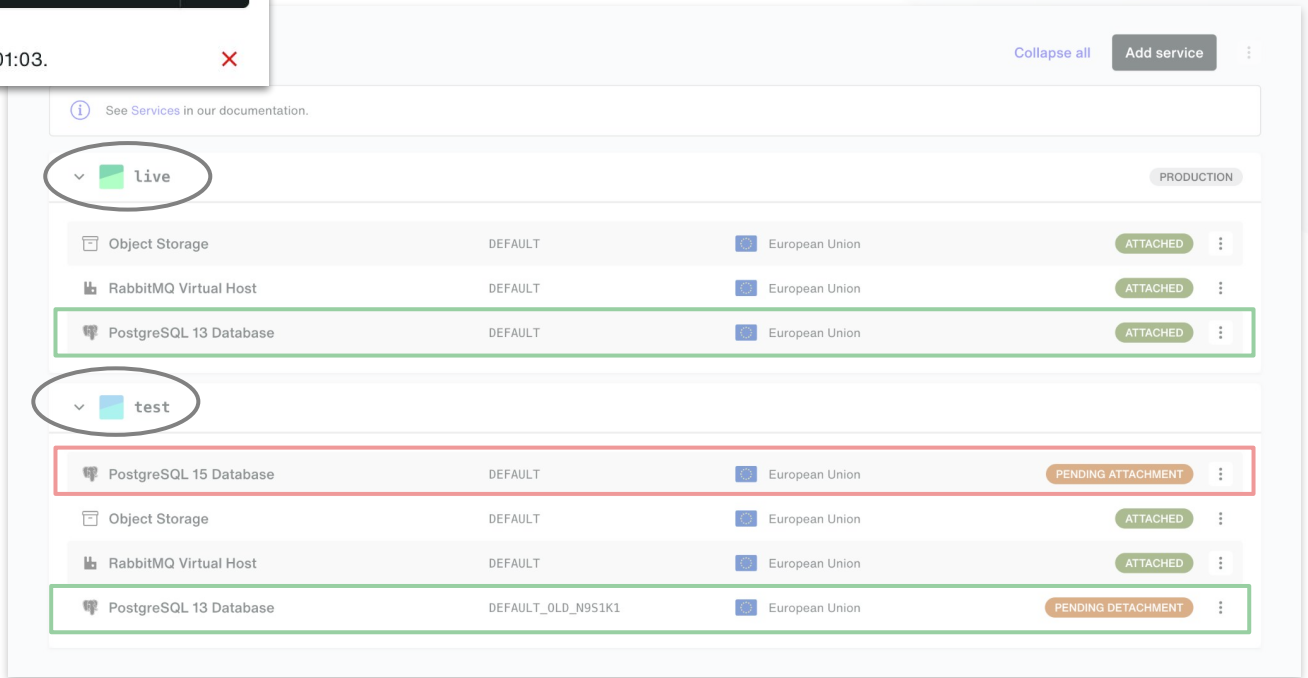
In case of failure...





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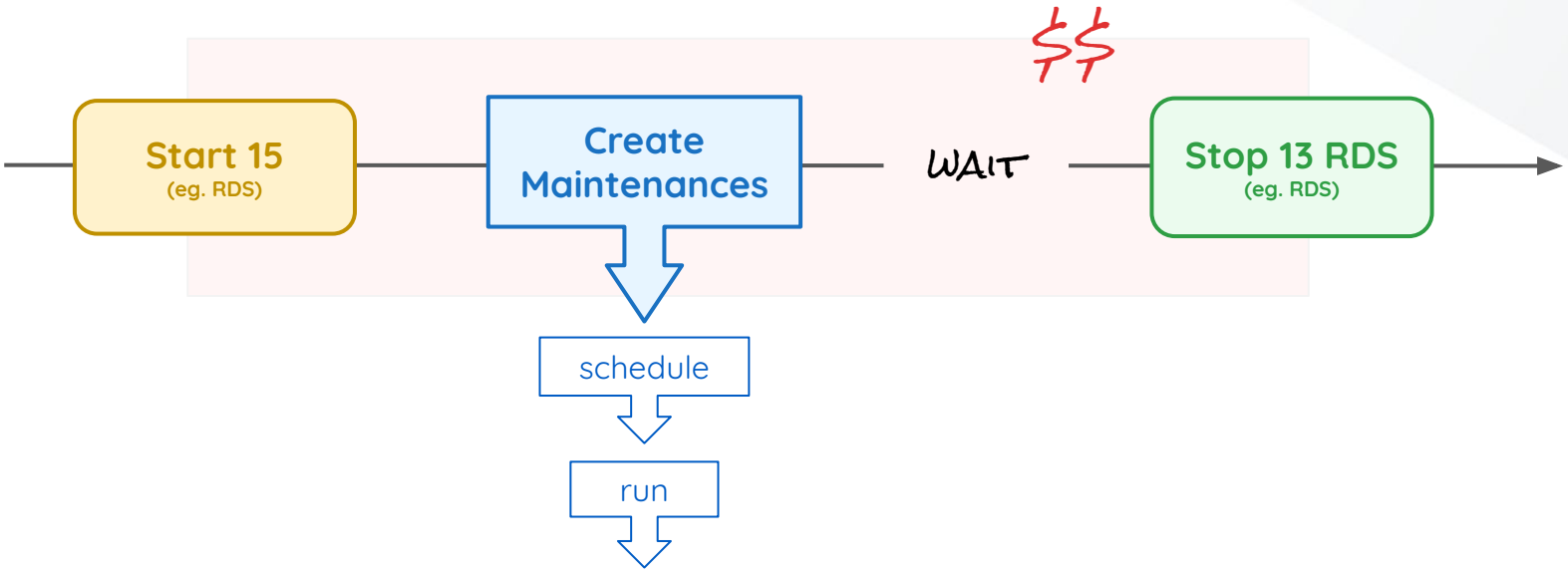
What about the cost?

On each region (in parallel)



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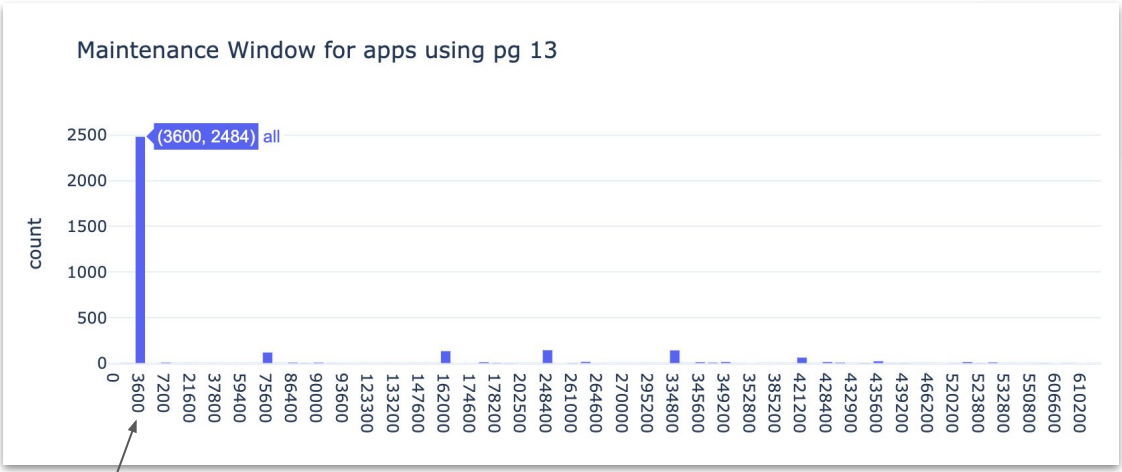
Now, the real world



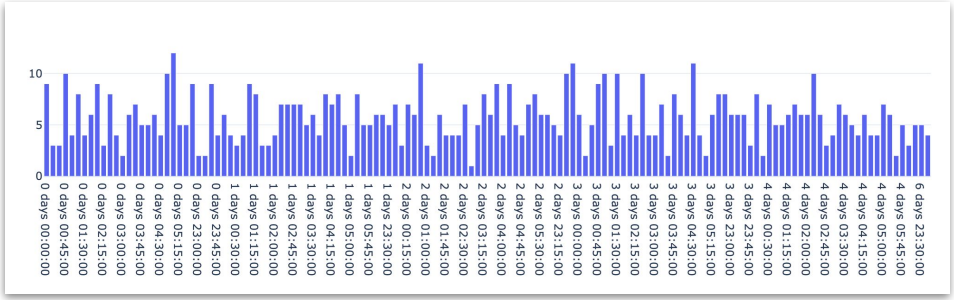
Monday, 3 am

Backup times

mean	00:00:19
std	00:02:22
min	00:00:00
75%	00:00:04
max	**00:51:25**

shuffle

(almost randomly)



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Let's do a first test ...

```
01:57:18.37 WEB         File "/usr/local/lib/python3.6/site-packages/django/db/backends/postgresql/base.py", line 178, in get_new_connection
01:57:18.37 WEB           connection = Database.connect(**conn_params)
01:57:18.37 WEB         File "/usr/local/lib/python3.6/site-packages/psycopg2/__init__.py", line 122, in connect
01:57:18.37 WEB           conn = _connect(dsn, connection_factory=connection_factory, **kwasync)
01:57:18.37 WEB       django.db.utils.OperationalError: SCRAM authentication requires libpq version 10 or above
01:57:18.37 WEB
01:57:18.37 WEB       unable to load app 0 (mountpoint='') (callable not found or import error)
01:57:18.37 WEB       *** no app loaded. GAME OVER ***
01:57:18.37 WEB       SIGINT/SIGQUIT received...killing workers...
01:57:18.38 WEB       gateway "uWSGI http 1" has been buried (pid: 17)
01:57:18.38 DEPLOYMENT connection error.
```

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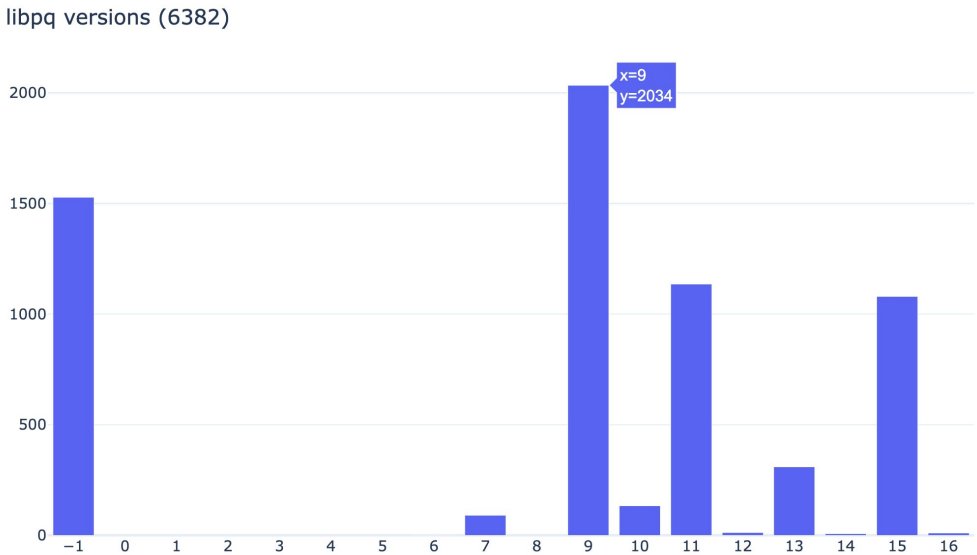
libpq

libpq is the C application programmer's interface to PostgreSQL.

PostgreSQL 14 Release Notes

- Change the default of the password_encryption server parameter to **scram-sha-256** (Peter Eisentraut)



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All **build** images are:

1. x86_64 linux
2. stored in our registry
3. only rebuilt on code change

backup

buildXYZ:tag
with libpq < 10

buildXYZ:tag_old
with libpq < 10

```
f"""
FROM {build_image}
COPY {libpq_exe} /tmp/
RUN lib_link=`find / -name libpq.so.5 | head -n 1` && lib_path=`readlink -f $lib_link` && dest=`dirname $lib_path`/{libpq_path.name} \\
  && mv /tmp/{libpq_exe} $dest \\
  && ln -sf $dest $lib_link
"""
```

⚠️ dynamically linked libraries (e.g. libssl)

repeat
2'000x

buildXYZ:tag
with libpq > 10

Base for the release image during migration

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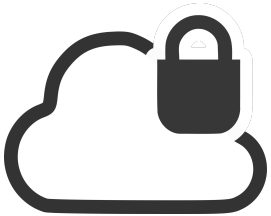
In **2** cases:

```
pg_restore [...]
ERROR: index row size 3048 exceeds btree version 4 maximum 2704 for index i
DETAIL: Index row references tuple (841,9) in relation t.
HINT: Values larger than 1/3 of a buffer page cannot be indexed. Consider a
function index of an MD5 hash of the value, or use full text indexing.

Command was: CREATE INDEX i ON public.t USING btree (bar);
```

ON RDS ONLY!

¯_(ツ)_/¯



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To sum up

Between **July** and **August**, with **1.5** engineers:

5'000+ migrations

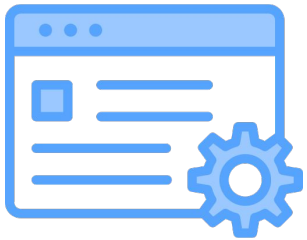
7'000+ databases

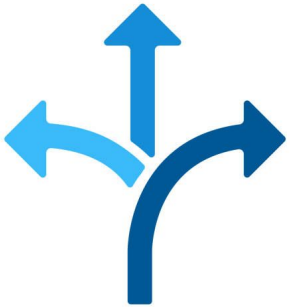
102 failures

99% libpq-related

2 index-related

99.98% success rate





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QUESTIONS
FOUND IN GOOGLE AUTOCOMPLETE
DO WHALES JUMP
ARE WITCHES GREEN
RE THERE MIRRORS ABOVE BEDS
DO I SAY UH
IS SEA SALT BETTER
WHY IS THERE NOT A POKEMON MMO
WHY IS THERE LAUGHING IN TV SHOWS
WHY ARE THERE DOORS ON THE FREEWAY
WHY ARE THERE SO MANY SVCHOST.EXE RUNNING
WHY AREN'T THERE ANY COUNTRIES IN ANTARCTICA
WHY ARE THERE SCARY SOUNDS IN MINECRAFT
WHY IS THERE KICKING IN MY STOMACH
WHY ARE THERE TWO SLASHES AFTER HTTP
WHY ARE THERE CELEBRITIES
WHY DO SNAKES EXIST
WHY DO OYSTERS HAVE PEARLS
WHY ARE DUCKS CALLED DUCKS
WHY DO THEY CALL IT THE CLAP
WHY ARE KYLE AND CARTMAN FRIENDS
WHY IS THERE AN ARROW ON AANG'S HEAD
WHY ARE TEXT MESSAGES BLUE
WHY ARE THERE MUSTACHES ON CLOTHES
WHY ARE THERE MUSTACHES ON CARS
WHY ARE THERE MUSTACHES EVERYWHERE
WHY ARE THERE SO MANY BIRDS IN OHIO
WHY IS THERE SO MUCH RAIN IN OHIO
WHY IS OHIO WEATHER SO WEIRD
WHY ARE THERE MALE AND FEMALE BIKES
WHY AREN'T THERE DINOSAUR GHOSTS
WHY DO IGUANAS DIE
WHY DO TESTICLES MOVE
WHY ARE THERE PSYCHICS
WHY ARE HATS SO EXPENSIVE
WHY DO YOUR BOOBS HURT
WHY ARE THERE SLAVES IN THE BIBLE
WHY DO TWINS HAVE DIFFERENT FINGERPRINTS
WHY ARE AMERICANS AFRAID OF DRAGONS
WHY IS YKK ON ALL ZIPPERS
WHY IS HTTPS CROSSED OUT IN RED
WHY IS THERE A LINE THROUGH HTTPS
WHY IS THERE A RED LINE THROUGH HTTPS ON FACEBOOK
WHY IS HTTPS IMPORTANT
WHY AREN'T MY ARMS GROWING
WHY DO I FEEL DIZZY
WHY AREN'T ECONOMISTS RICH
WHY DO AMERICANS CALL IT SOCCER
WHY ARE MY EARS RINGING
WHY ARE THERE SO MANY AVENGERS
WHY ARE THE AVENGERS FIGHTING THE X MEN
WHY IS WOLVERINE NOT IN THE AVENGERS
WHY IS THERE LAVA
WHY IS THERE PHLEGM
WHY ARE THERE SO MANY CROWS IN ROCHESTER, MN
WHY IS PSYCHIC WEAK TO BUG
WHY DO CHILDREN GET CANCER
WHY IS POSEIDON ANGRY WITH ODYSSEUS
WHY IS THERE ICE IN SPACE
WHY ARE THERE ANTS IN MY LAPTOP
WHY IS EARTH TILTED
WHY IS SPACE BLACK
WHY IS OUTER SPACE SO COLD
WHY ARE THERE PYRAMIDS ON THE MOON
WHY IS NASA SHUTTING DOWN
WHY ARE THERE GHOSTS
WHY IS THERE AN OWL IN MY BACKYARD
WHY IS THERE AN OWL OUTSIDE MY WINDOW
WHY IS THERE AN OWL ON THE DOLLAR BILL
WHY DO OWLS ATTACK PEOPLE
WHY ARE AK 47s SO EXPENSIVE
WHY ARE THERE HELICOPTERS CIRCLING MY HOUSE
WHY ARE THERE GODS
WHY ARE THERE TWO SPOCKS
WHY ARE DOGS AFRAID OF FIREWORKS
WHY IS THERE NO KING IN ENGLAND
WHY ARE THERE BRIDESMAIDS
WHY DO DYING PEOPLE REACH UP
WHY AREN'T THERE VARICOSE ARTERIES
WHY ARE OLD KLINGONS DIFFERENT
WHY ARE THERE TINY SPIDERS IN MY HOUSE
WHY DO SPIDERS COME INSIDE
WHY ARE THERE HUGE SPIDERS IN MY HOUSE
WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE
WHY ARE THERE SPIDERS IN MY ROOM
WHY ARE THERE SO MANY SPIDERS IN MY ROOM
WHY DO SPIDER BITES ITCH
WHY IS DYING SO SCARY
WHY IS THERE HELL IF GOD FORGIVES
WHY ARE THERE SQUIRRELS
WHY ARE THERE FEMALE MR MIMES
WHY IS MT VESUVIUS THERE
WHY DO THEY SAY T MINUS
WHY ARE THERE OBELISKS
WHY ARE WRESTLERS ALWAYS WET
WHY ARE OCEANS BECOMING MORE ACIDIC
WHY IS ARWEN DYING
WHY AREN'T MY QUAIL LAYING EGGS
WHY AREN'T MY QUAIL EGGS HATCHING
WHY AREN'T THERE ANY FOREIGN MILITARY BASES IN AMERICA
WHY IS LIFE SO BORING
WHY ARE MY BOOBS ITCHY
WHY ARE CIGARETTES LEGAL
WHY ARE THERE DUCKS IN MY POOL
WHY IS JESUS WHITE
WHY IS THERE LIQUID IN MY EAR
WHY DO Q TIPS FEEL GOOD
WHY DO GOOD PEOPLE DIE
WHY AREN'T THERE GUNS IN HARRY POTTER
WHY ARE ULTRASOUNDS IMPORTANT
WHY IS STEALING WRONG
WHY IS PROGRAMMING SO HARD
WHY IS THERE A 0 OHM RESISTOR
WHY DO AMERICANS HATE SOCCER
WHY DO RHYMES SOUND GOOD
WHY DO TREES DIE
WHY IS THERE NO SOUND ON CNN
WHY AREN'T POKEMON REAL
WHY AREN'T BULLETS SHARP
WHY DO DREAMS SEEM SO REAL
WHY IS THERE NO GPS IN LAPTOPS
WHY DO KNEES CLICK
WHY AREN'T THERE E GRADES
WHY IS ISOLATION BAD
WHY DO BOYS LIKE ME
WHY DON'T BOYS LIKE ME
WHY IS THERE ALWAYS A JAVA UPDATE
WHY ARE THERE RED DOTS ON MY THIGHS
WHY IS LYING GOOD
WHY IS GPS FREE
WHY IS SEX SO IMPORTANT

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https://github.com/derlin/hello-silicon-chalet

https://derlin.ch

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