
SHRIEK!

Scaling fashionably

How PostgreSQL helped Zalando to become one of the biggest online fashion retailers in Europe

About me

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ZALANDO
SHOP
NEU
%

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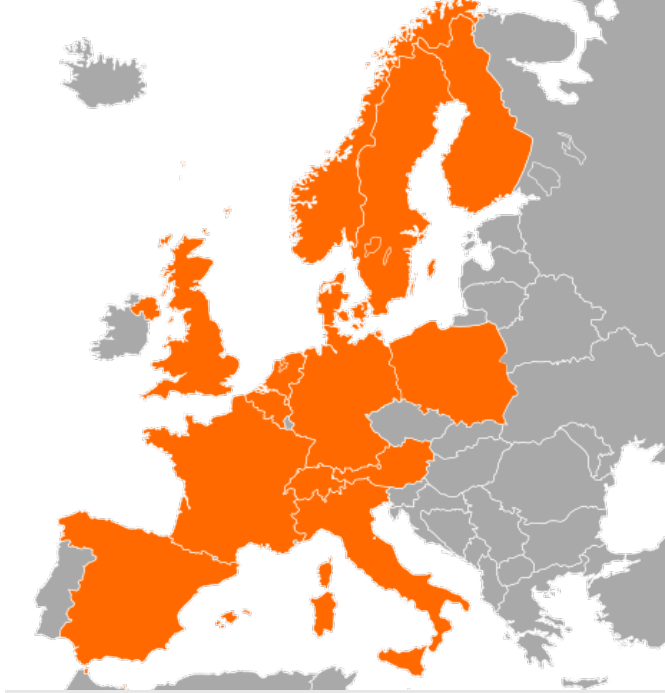
One of Europe's largest online fashion retailers



15 countries

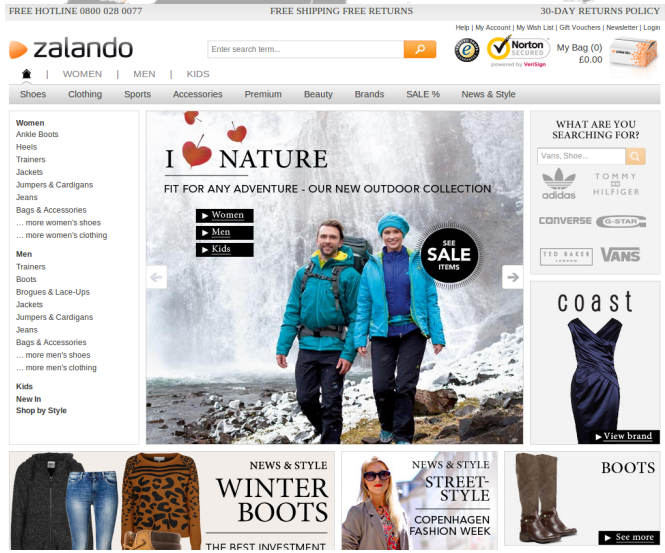
3 fulfillment centers

13.7+ million active customers

1.8 billion € revenue 2013

150,000+ products

640+ million visits in first half-year 2014




ZALANDO
SHOP


SOLR
Zalando
SHOP
MOBILE
LOUNGE
3rd PARTY
TOOLING
SERVICE 1
SERVICE 2
SERVICE 3
SERVICE 5
SERVICE 6
POSTGRE SQL
BI
LOGISTICS

Some more numbers

200+ deployment units (WARs)

1300+ production instances

80+ database master instances

90+ different databases

300+ developers

10 database engineers

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Even more numbers

- > 4.0 TB of PostgreSQL data
- Biggest instances (not counted before)
  - `eventlogdb (3TB)`
    - 20 GB per week
  - `riskmgmtdb (5TB)`
    - 12 GB per day

Biggest challenges

- Constantly growing
- Fast development cycles
- No downtimes are tolerated

Agenda

How we

- access data
- change data models without downtimes
- shard without limits
- monitor

Agenda

How we

- **access data**
- change data models without downtimes
- shard without limits
- monitor

Accessing data

- customer
  - bank account
  - order -> bank account
    - order position
  - return order -> order
    - return position -> order position
  - financial document
    - financial transaction -> order

Accessing data

NoSQL

- map your object hierarchy to a document
- (de-)serialization is easy
- transactions are not needed

- No SQL
- implicit schemas are tricky

Accessing data

ORM

- is well known to developers
- CRUD operations are easy
- all business logic inside your application
- developers are in their comfort zone

Accessing data

ORM

- is well known to developers
- CRUD operations are easy
- all business logic inside your application
- developers are in their comfort zone

- error prone transaction management
- you have to reflect your tables in your code
- all business logic inside your application
- schema changes are not easy

Accessing data

Are there alternatives to ORM?

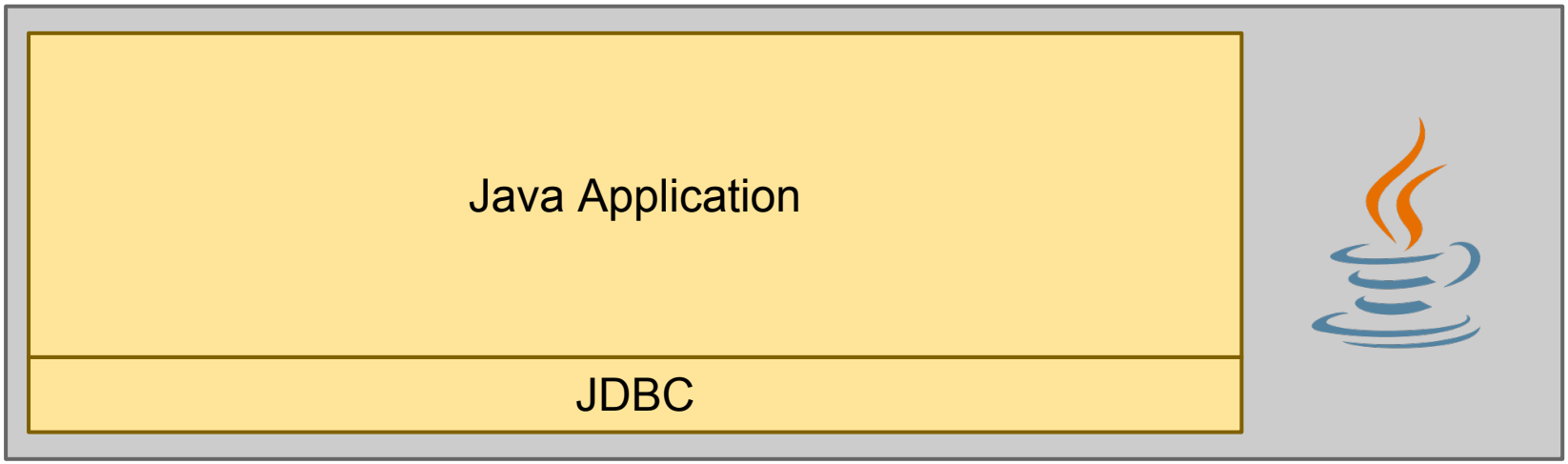
Accessing data

Are there alternatives to ORM?

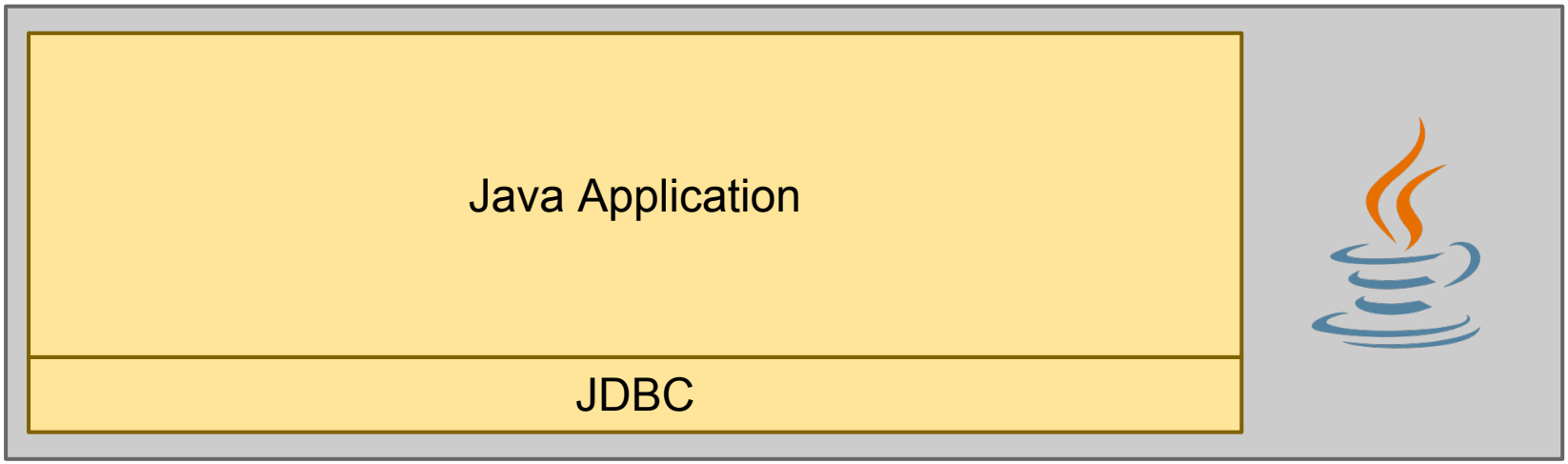
Stored Procedures

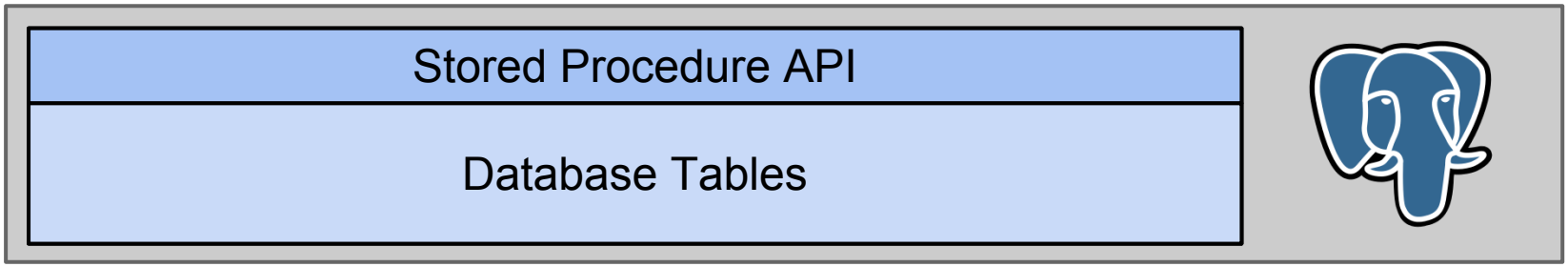
- return/receive entity aggregates
- clear transaction scope
- more data consistency checks
- independent from underlying data schema

Accessing data

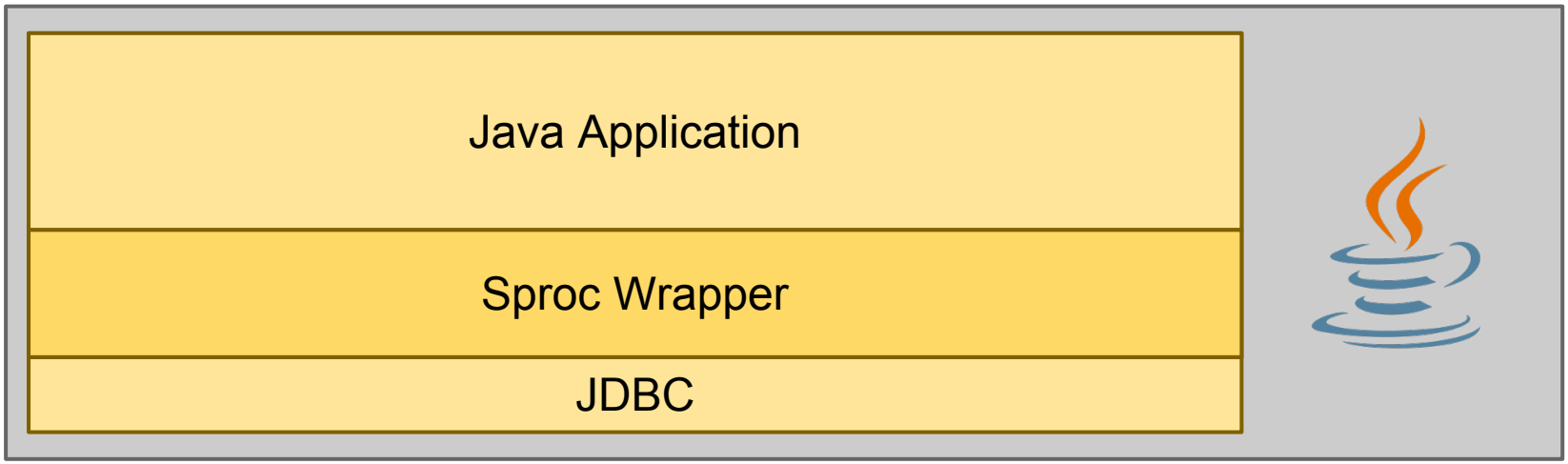


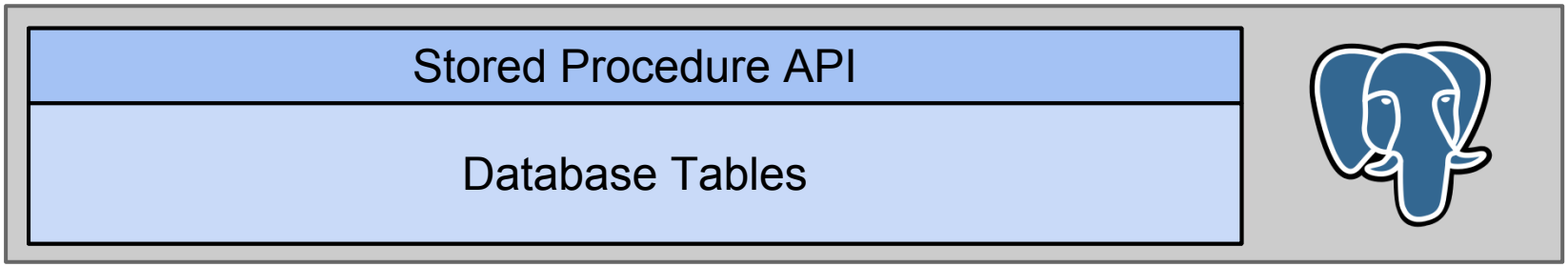
Accessing data





Java Sproc Wrapper





Java Sproc Wrapper

SQL

```
CREATE FUNCTION register_customer(p_email  text,
                                  p_gender z_data.gender)
                RETURNS int
AS $$
    INSERT INTO z_data.customer (c_email, c_gender)
         VALUES (p_email, p_gender)
      RETURNING c_id
$$
LANGUAGE 'sql' SECURITY DEFINER;
```

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Java Sproc Wrapper

JAVA

```java
@SProcService
public interface CustomerSProcService {
    @SProcCall
    int registerCustomer(@SProcParam String email,
                         @SProcParam Gender gender);
}
```

SQL

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Java Sproc Wrapper

JAVA

```java
@SProcCall
List<Order> findOrders(@SProcParam String email);
```

SQL

```sql
CREATE FUNCTION find_orders(p_email text,
                            OUT order_id int,
                            OUT order_created timestamptz,
                            OUT shipping_address order_address)
                RETURNS SETOF record
AS $$
      SELECT o_id, o_created,
             ROW(oa_street, oa_city, oa_country)::order_address
        FROM z_data."order"
        JOIN z_data.order_address ON oa_order_id = o_id
        JOIN z_data.customer ON c_id = o_customer_id
       WHERE c_email = p_email
$$
LANGUAGE 'sql' SECURITY DEFINER;
```

Java Sproc Wrapper

JAVA

```java
@SProcCall
List<Order> findOrders(@SProcParam String email);
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SQL

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                            OUT shipping_address order_address)
                RETURNS SETOF record
AS $$
      SELECT o_id, o_created,
             ROW(oa_street, oa_city, oa_country)::order_address
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Stored Procedures
for developers

- CRUD operations need too much code
- Developers have to learn SQL
- Developers can write bad SQL
- Code reviews are needed

Stored Procedures
for developers

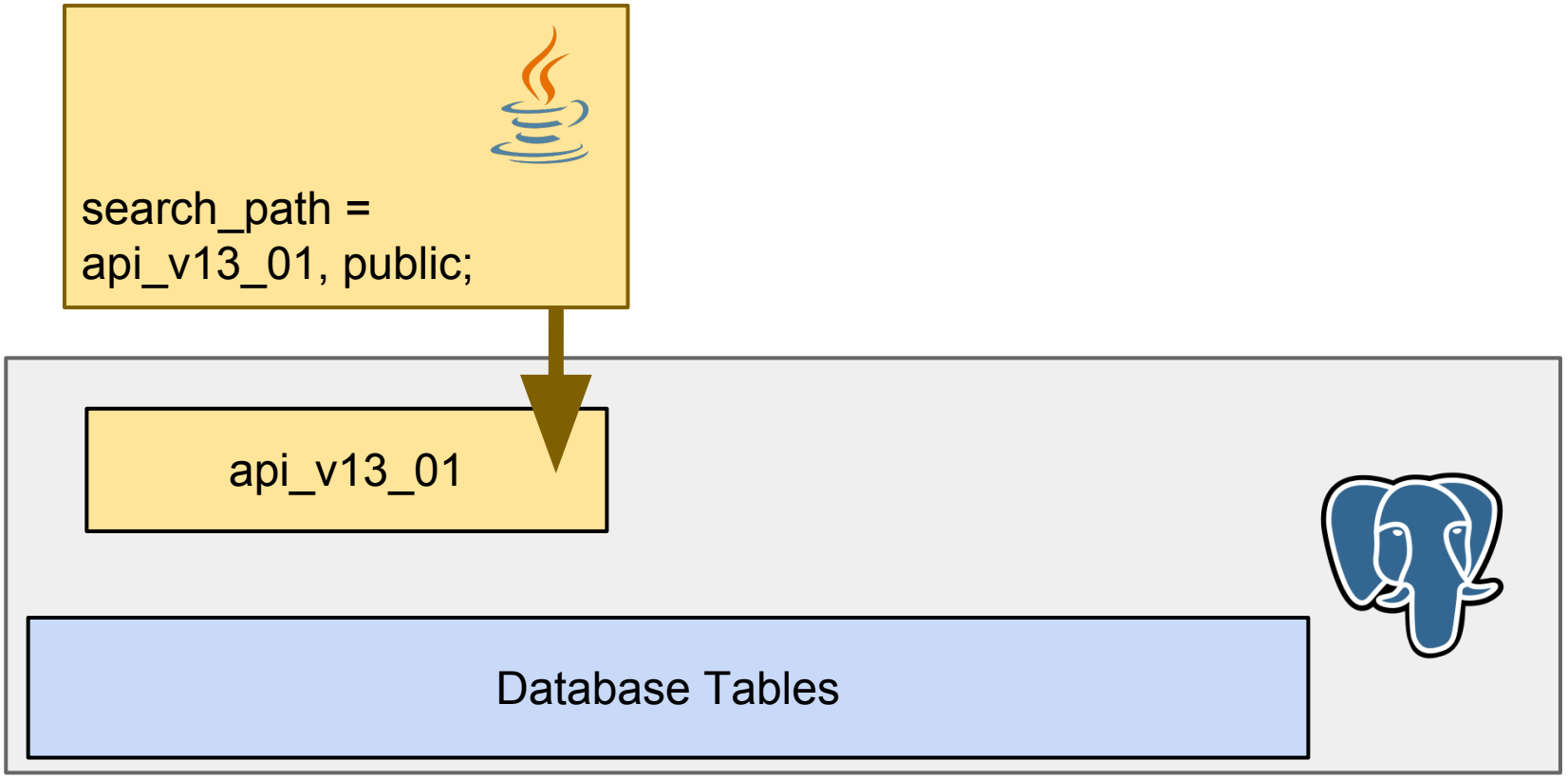
- CRUD operations need too much code
- Developers have to learn SQL
- Developers can write bad SQL
- Code reviews are needed

- Use-case driven
- Developers have to learn SQL
- Developers learn how to write good SQL

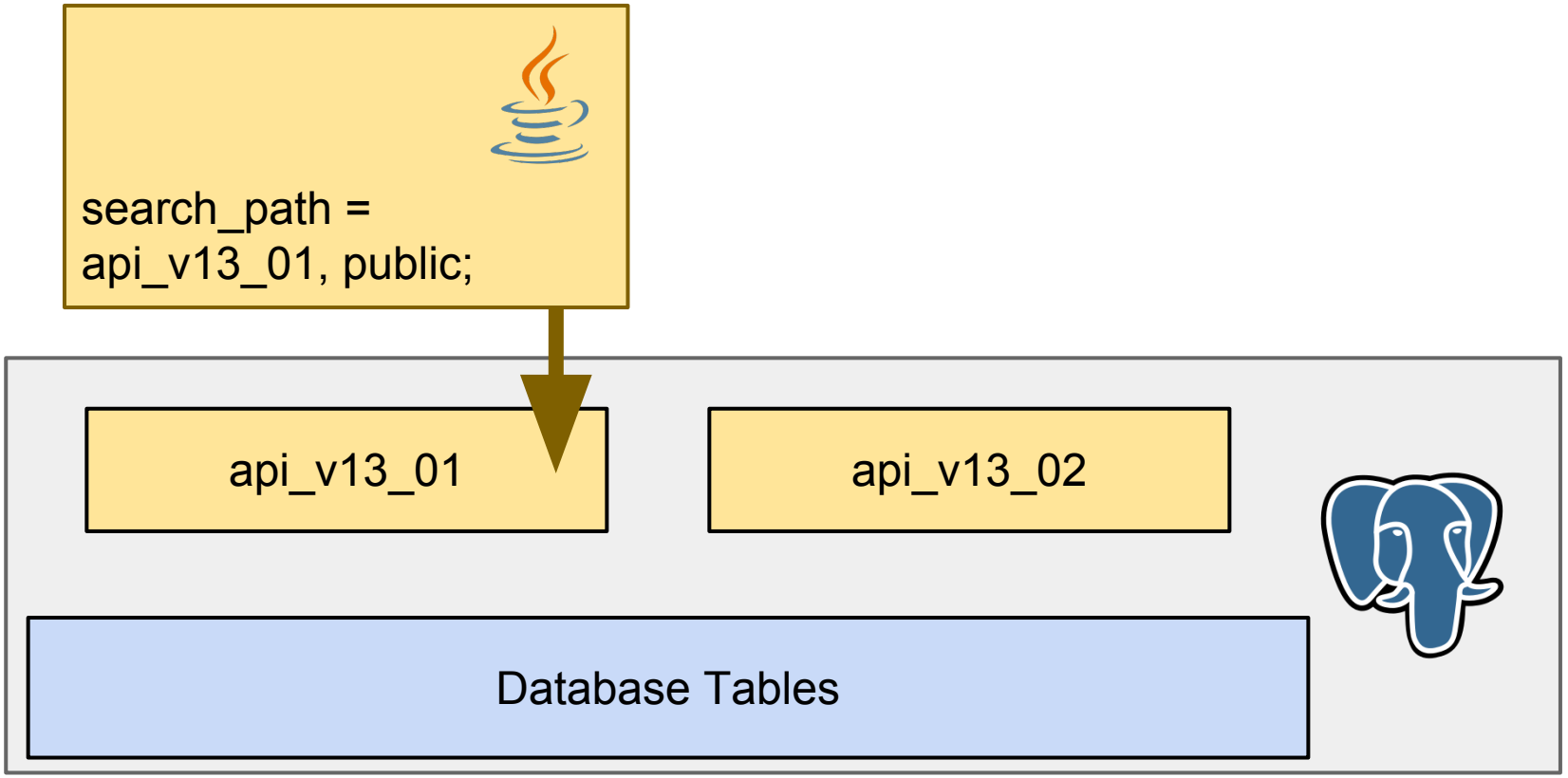
Horror story

- Never map your data manually
- Educate yourself

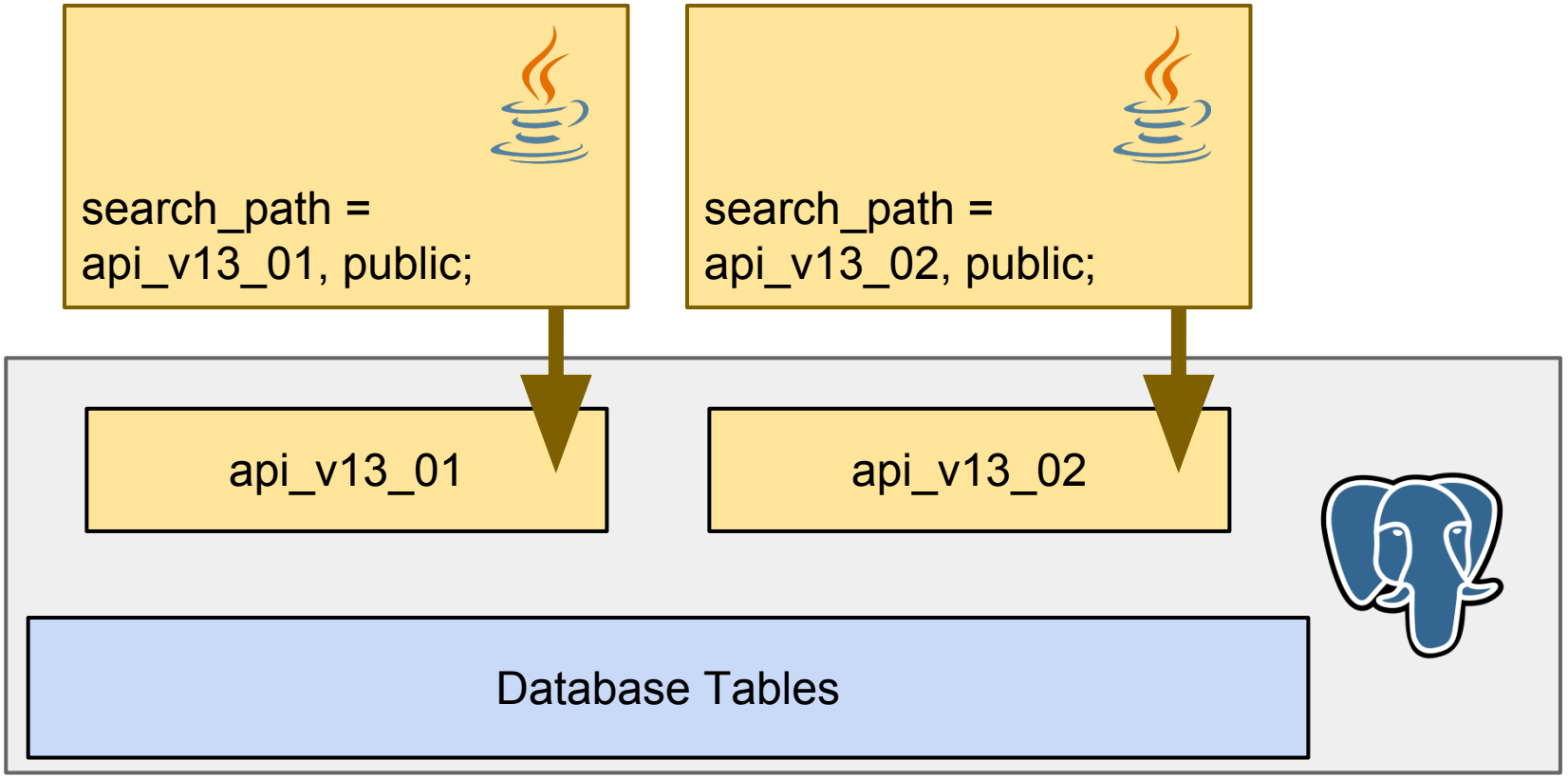
Stored Procedure
API versioning



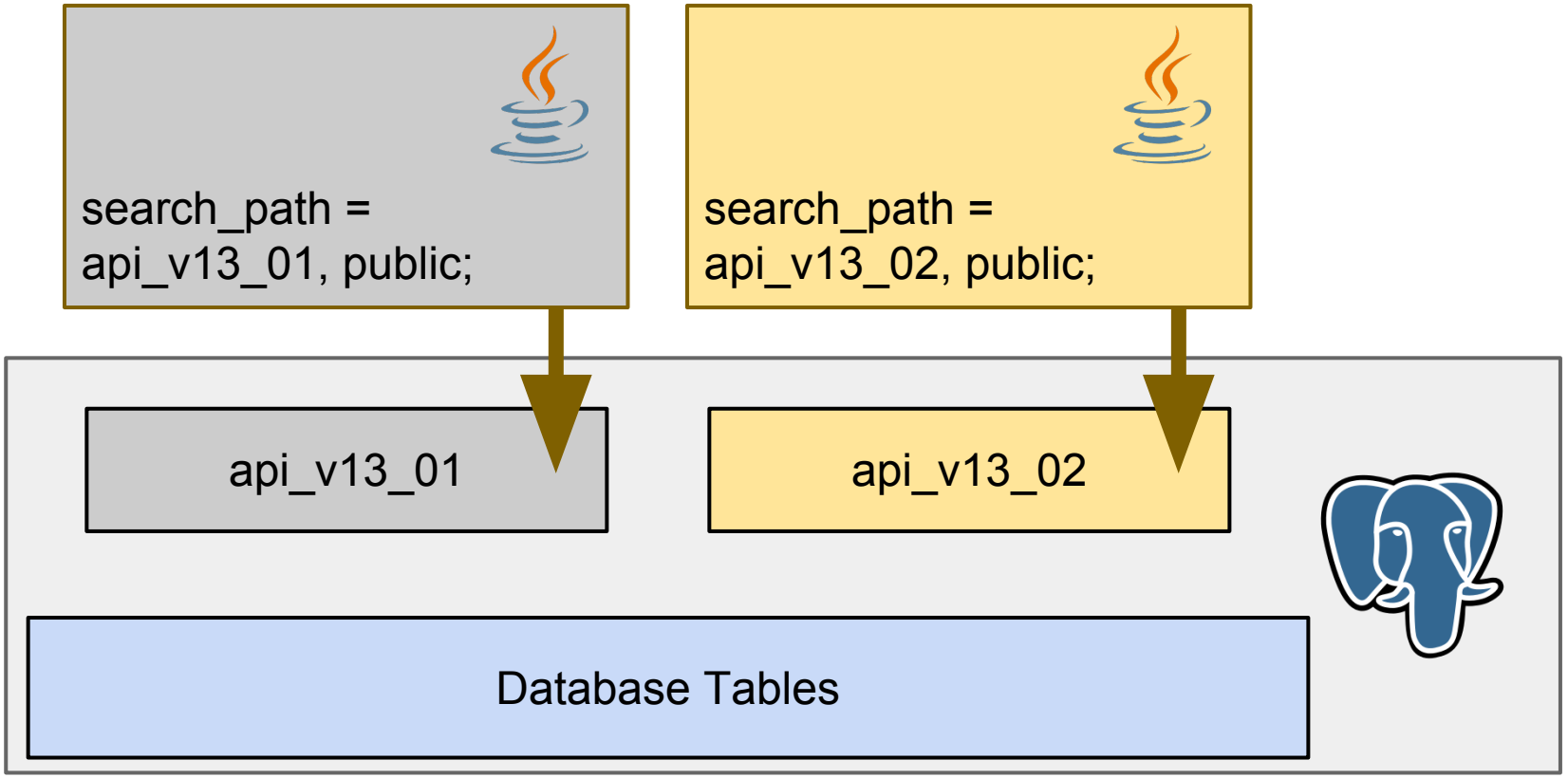
Stored Procedure
API versioning



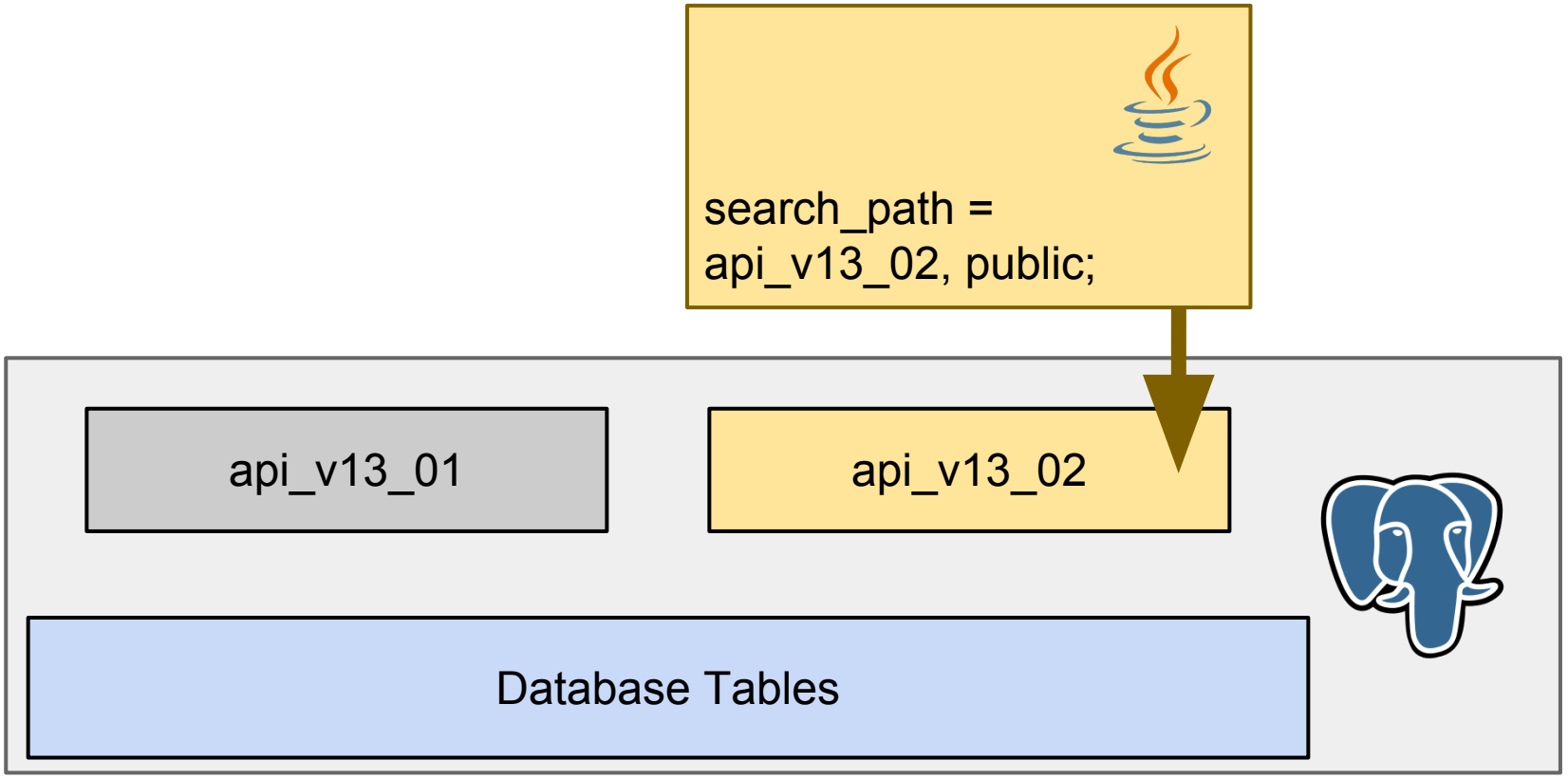
Stored Procedure
API versioning



Stored Procedure
API versioning



Stored Procedure
API versioning



Stored Procedure
API versioning

- Tests are done to the whole API version
- No API migrations needed
- Deployments are fully automated

Agenda

How we

- access data
- **change data models without downtimes**
- shard without limits
- monitor

Easy schema changes

- PostgreSQL
  - Schema changes with minimal locks with:
    `ADD/RENAME/DROP COLUMN`
    `ADD/DROP DEFAULT VALUE`
  - `CREATE/DROP INDEX CONCURRENTLY`
  - Constraints are still difficult to `ALTER`

    (becoming much better in 9.4)

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Easy schema changes

- Stored Procedure API layer
  - Can fill missing data on the fly
  - Helps to change data structure without application noticing it

Easy schema changes

- Read and write to *old* structure
- Write to both structures, *old* and *new.*
  Try to read from *new*, fallback to *old*
- Migrate data
- Read from new, write to *old* and *new*

Easy schema changes

- Schema changes using SQL script files
  - SQL scripts written by developers (DBDIFFs)
  - registering DBDIFFs with `Versioning`
  - should be reviewed by DB guys
  - DB guys are rolling DB changes on the live system

Easy schema changes

DBDIFF SQL

```
BEGIN;
    SELECT _v.register_patch('ZEOS-5430.order');

    CREATE TABLE z_data.order_address (
      oa_id int SERIAL,
      oa_country z_data.country,
      oa_city varchar(64),
      oa_street varchar(128), ...
    );

    ALTER TABLE z_data."order" ADD o_shipping_address_id int
      REFERENCES z_data.order_address (oa_id);
COMMIT;
```

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Easy schema changes

DBDIFF SQL

```
BEGIN;
    SELECT _v.register_patch('ZEOS-5430.order');

    \i order/database/order/10_tables/10_order_address.sql

    ALTER TABLE z_data."order" ADD o_shipping_address_id int
      REFERENCES z_data.order_address (oa_id);
COMMIT;
```

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Easy schema changes

DBDIFF SQL

```
BEGIN;
    SELECT _v.register_patch('ZEOS-5430.order');

    \i order/database/order/10_tables/10_order_address.sql

    SET statement_timeout TO ‘3s’;

    ALTER TABLE z_data."order" ADD o_shipping_address_id int
      REFERENCES z_data.order_address (oa_id);
COMMIT;
```

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Easy schema changes

Overview of R13_00_44

Warning! 11 patch names exists in multiple files!

Project	Database	Diff	Reviewed	Integration	Release	Patch	LIVE
		backend - 18/19					
de.zalando.admin/admin-backend							
	admin						
		ZEOS-24617.admin	A S	1 / 1	1 / 1	1 / 1	1 / 1
de.zalando/bm							
	bm						
		ORDER-453.bm	S A	0 / 1	1 / 1	1 / 1	1 / 1
de.zalando/config-service							
	config						
		ZEOS-21566.data	A A S	1 / 1	1 / 1	1 / 1	1 / 1
		ZEOS-24840.data	S A	1 / 1	1 / 1	1 / 1	1 / 1
		ZEOS-25486.data	A	0 / 1	1 / 1	0 / 1	1 / 1

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Easy schema changes

purchasing - 6/10						
de.zalando/purchasing-backend						
	purchase					
		ZEOS-19134.1.purchase	A	0 / 1	0 / 1	0 / 1	0 / 1
		ZEOS-23911.purchase	A S	0 / 1	1 / 1	1 / 1	1 / 1
		ZEOS-24134.purchase	S A	1 / 1	1 / 1	1 / 1	1 / 1
		ZEOS-24484.purchase	A S	0 / 1	1 / 1	1 / 1	1 / 1
		ZEOS-24597.purchase	A S	1 / 1	1 / 1	1 / 1	1 / 1
		ZEOS-25078.purchase	S A	0 / 1	1 / 1	1 / 1	1 / 1
		ZEOS-25272.purchase		1 / 1	0 / 1	0 / 1	0 / 1
		ZEOS-25425.purchase		0 / 1	1 / 1	1 / 1	1 / 1
		ZEOS-25428.purchase.data		1 / 1	1 / 1	0 / 1	0 / 1
		ZEOS-25521.purchase.data		0 / 1	0 / 1	0 / 1	0 / 1
shared - 1/1						
de.zalando/zalando-db-commons						
	commons					
		ORDER-405.db-commons	S A	16 / 58	20 / 57	19 / 57	17 / 59

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Easy schema changes

No downtime due to migrations or

deployment since we use PostgreSQL

Easy schema changes

One downtime due to migrations or

deployment since we use PostgreSQL

Horror story

- Invest in staging environments
- Do not create artificial process bottlenecks
- Educate yourself

Agenda

How we

- access data
- change data models without downtimes
- **shard without limits**
- monitor

One big database

- Joins between any entities
- Perfect for BI
- Simple access strategy
- Less machines to manage

One big database

- Data does not fit into memory
- OLTP becomes slower
- Longer data migration times
- Database maintenance tasks take longer

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Sharded database

- Data fits into memory
- IO bottleneck wider
- OLTP is fast again
- Data migrations are faster
- Database maintenance tasks are faster

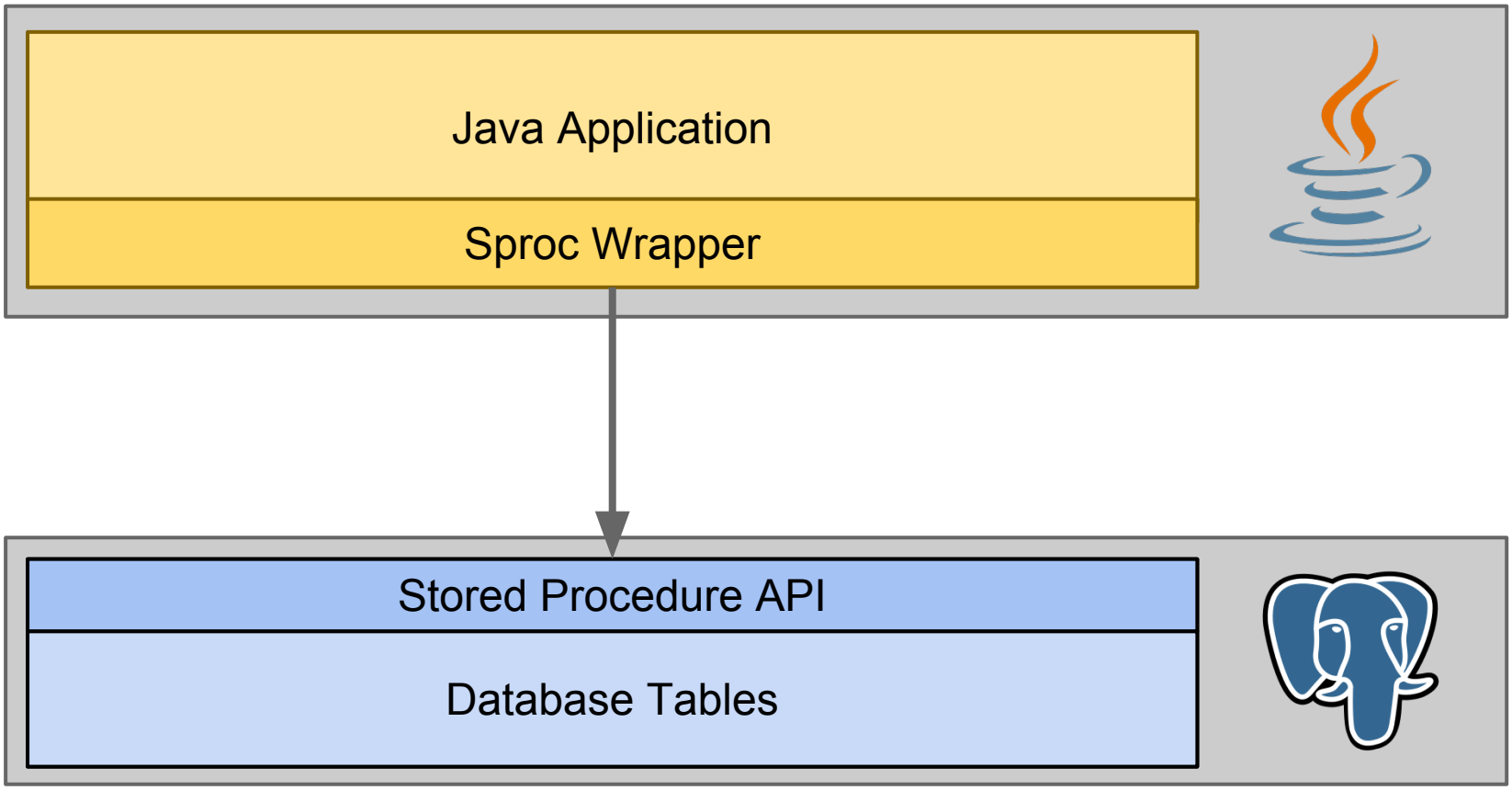
Sharded database

- Joins only between entities aggregates
- BI need more tooling
- Accessing data needs more tooling
- Managing more servers needs more tooling

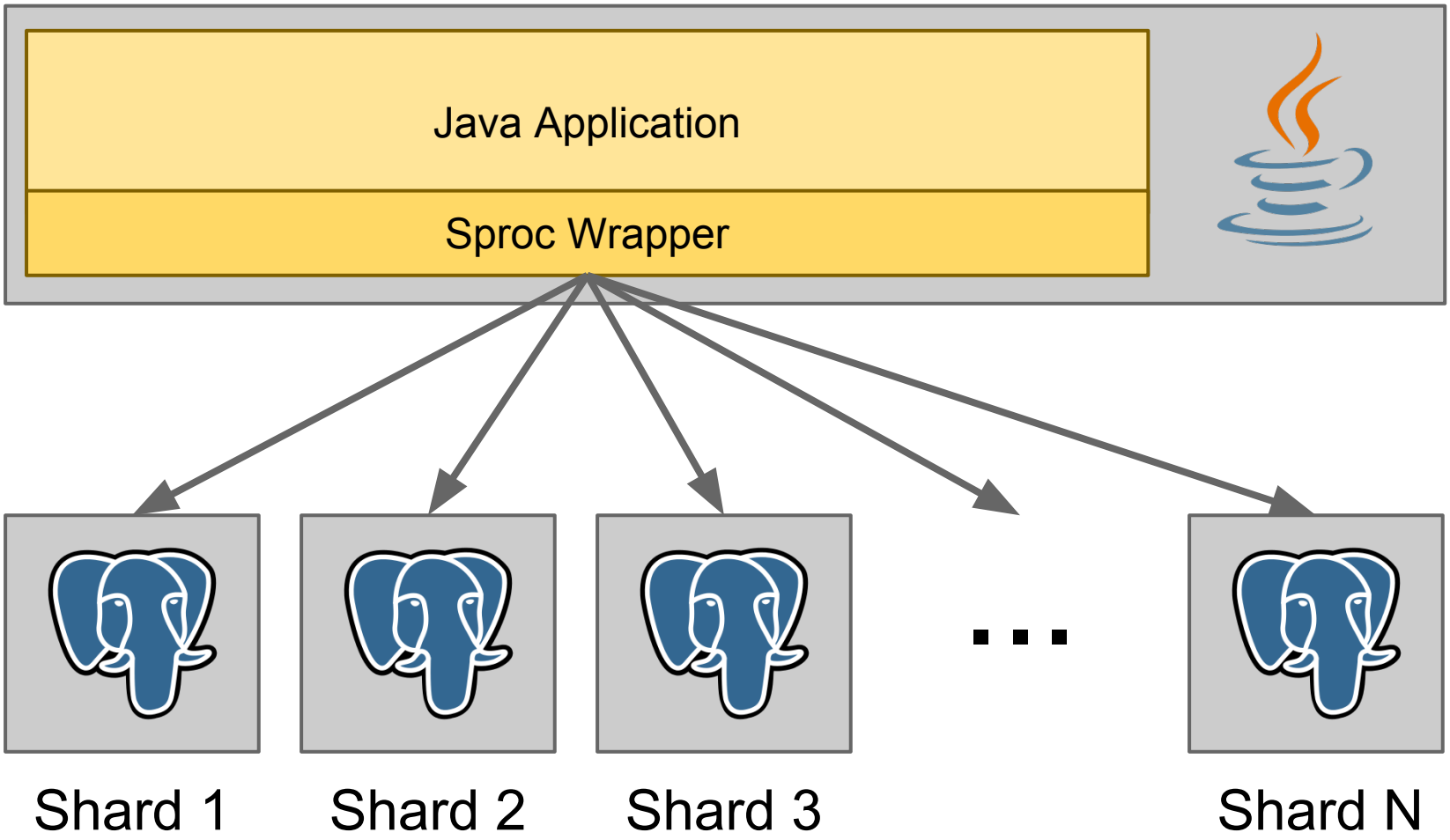
Sharded database

- Need more tooling

Sharding without limits



Sharding without limits



Sharding with Java Sproc Wrapper

JAVA

```java
@SProcCall
int registerCustomer(@SProcParam @ShardKey CustomerNumber customerNumber,
                     @SProcParam String email,
                     @SProcParam Gender gender);
```

JAVA

```java
@SProcCall
Article getArticle(@SProcParam @ShardKey Sku sku);
```

JAVA

```java
@SProcCall(runOnAllShards = true, parallel = true)
List<Order> findOrders(@SProcParam String email);
```

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Sharding with Java Sproc Wrapper

Entity lookup strategies

- search on all shards (in parallel)
- hash lookups
- unique *shard aware* ID
  - Virtual Shard IDs (pre-sharding)

Agenda

How we

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- shard without limits
- **monitor**

Monitoring

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pg_view

```
postgres@z-integrationdb: ~ 134x29
z-integrationdb up 117 days, 10:08:47 32 cores Linux 3.2.0-48-generic load average 0.73 0.63 0.51                    22:10:13
sys: utime 1.7   stime 0.3   idle 98.0  iowait 0.0   ctxt 2500 run 3   block 0
mem: total 251.9GB free 34.0GB buffers 1.6GB  cached 196.4GB dirty 10.0MB limit 127.8GB as 33.6GB left 94.2GB
integration93 9.3 database connections: 8 of 800 allocated, 2 active
type dev                fill   total   left   read  write    await path_size path
data mapper/vg01-data1   0.0   2.2TB  1.3TB                          37.1MB /data/postgres/pgsql_integration93/9.3/data
xlog sda9                0.0 119.0GB 88.5GB    0.0    0.3      0.0    64.0MB /data/postgres/pgsql_integration93/9.3/data/pg_xlog/
  pid type    s utime stime guest read write   age db           user          query
 4595 backend S   0.0   0.0   0.0  0.0   0.0 01:37 integr..ory_db vgogichashvili idle in transaction
 5019 backend S   0.0   0.0   0.0  0.0   0.0 01:02 integr..ory_db vgogichashvili select 'Cool tool' from pg_sleep(19000);

s: System processes   f: Freeze output   u: Measurement units   a: Autohide fields   t: No trim   r: Realtime   h: Help      v.1.1.0
```

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Monitoring

- Tools
  - psql wrapper on DBA client machines
    - `psql_<instance>_<ENV>`
  - aliases on the host machines
    - `pg_ctl_<instance>`
    - `psql_<instance>`
    - `pg_taillog_<instance>`
  - helper scripts
    - assign or remove service/elastic IPs
    - backup all instances on the host

Monitoring

- Nagios/Icinga (being replaced by ZMON2)
- Dedicated 24x7 monitoring team
- Custom monitoring infrastructure ZMON2

PGObserver

perftables/

Possible Table access/growth issues report

Hostname: bm.db.zalando

Timeframe: 2013-10-26 2013-10-29 show

Host	Schema	Table	Date	Scan change %	Scans1	Scans2	Size1	Size2
bm.db.zalando	zbm_data	sales_rule_set	2013-10-28	84.21 (50)	38	70	2022 MB	2022 MB

perfindexes/

Possible Index issues report

Hostname: catalog1.db.zalando

show

Invalid indexes (in total size of 0 bytes)

Hostname	Table name	Index name	Index size	% of table's indexes	Table size
catalog1.db.zalando	zcat_data.article_config	zcat_data.article_config_c1_c2_null_null_null_uidx	0 bytes	0.0% of 87 MB	42 MB

Duplicate indexes

Hostname	Table name	Table size	Index definition	Count
catalog1.db.zalando	zcat_data.article_simple	171 MB	CREATE INDEX X ON zcat_data.article_simple USING btree (as_simple_sku_id)	2
catalog1.db.zalando	zcat_data.article_config	130 MB	CREATE INDEX X ON zcat_data.article_config USING btree (ac_config_sku_id)	2
catalog1.db.zalando	zcat_data.article_model	47 MB	CREATE INDEX X ON zcat_data.article_model USING btree (am_model_sku_id)	2
catalog1.db.zalando	zcat_commons.size	12 MB	CREATE INDEX X ON zcat_commons.size USING btree (s_size_chart_code, s_code)	2
catalog1.db.zalando	zcat_commons.price_level	96 kB	CREATE INDEX X ON zcat_commons.price_level USING btree (pl_level)	2

Unused indexes

Hostname	Table name	Index name	Scans	Index size	% of table's indexes	Table size

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PGObserver

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What we are working at

- DaaS
- Continuous deployment (including the DBs)
- PGObserver 2.0 (join the effort!)

Links

SProcWrapper – Java library for stored procedure access
github.com/zalando/java-sproc-wrapper

PGObserver – monitoring web tool for PostgreSQL
github.com/zalando/PGObserver

`pg_view` – top-like command line activity monitor
github.com/zalando/pg_view

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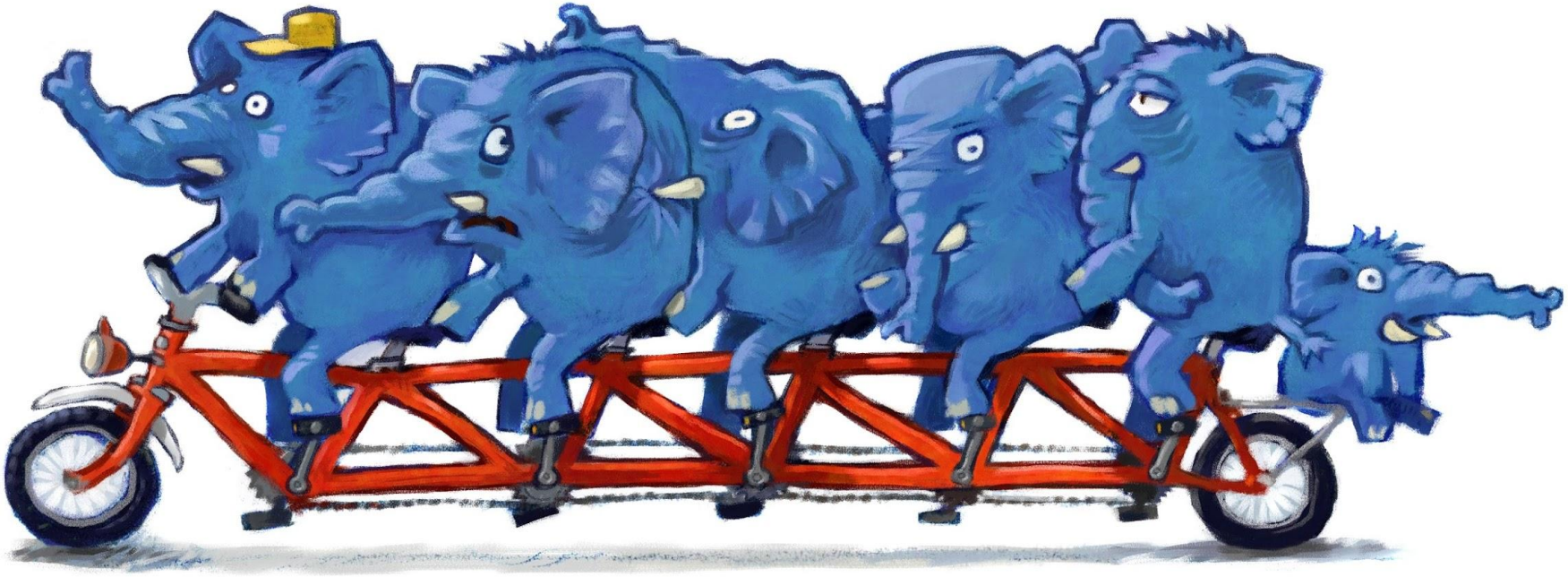
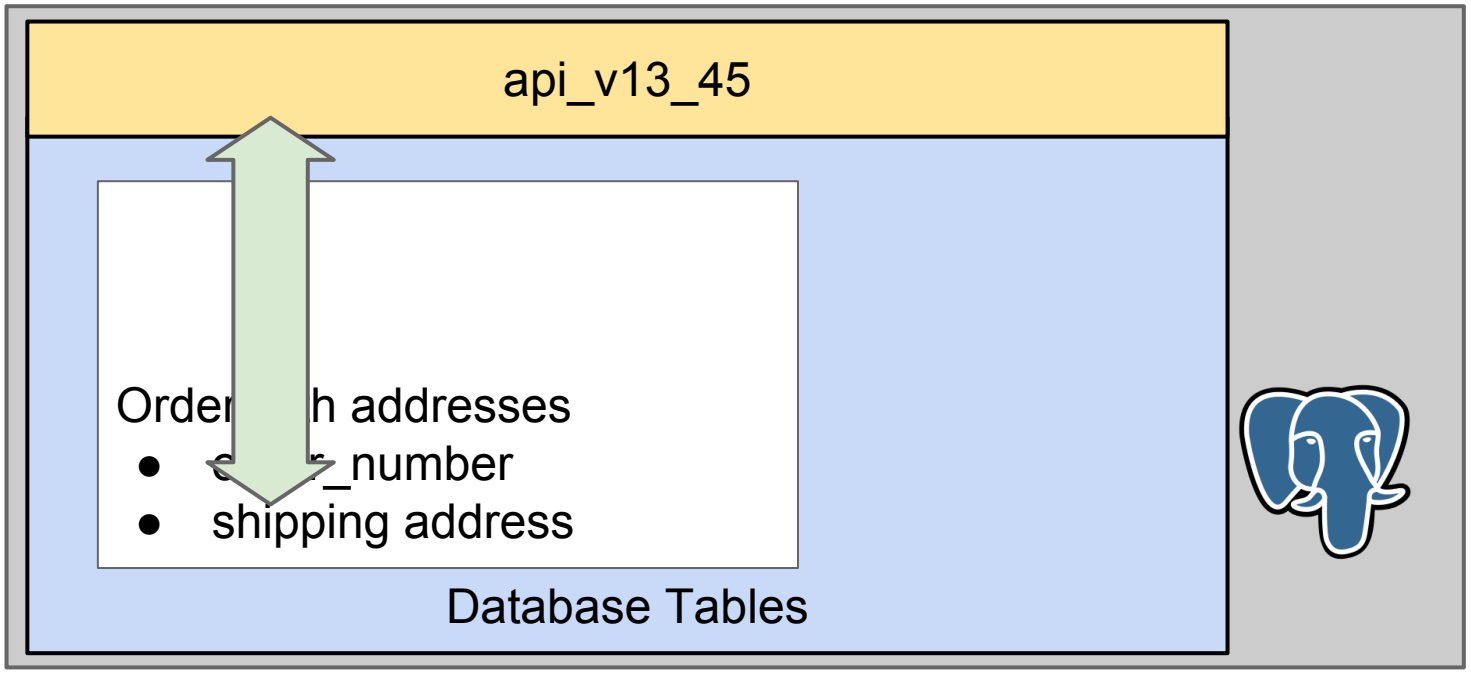


Thank you!

Easy schema changes

search_path =
api_v13_45, public;

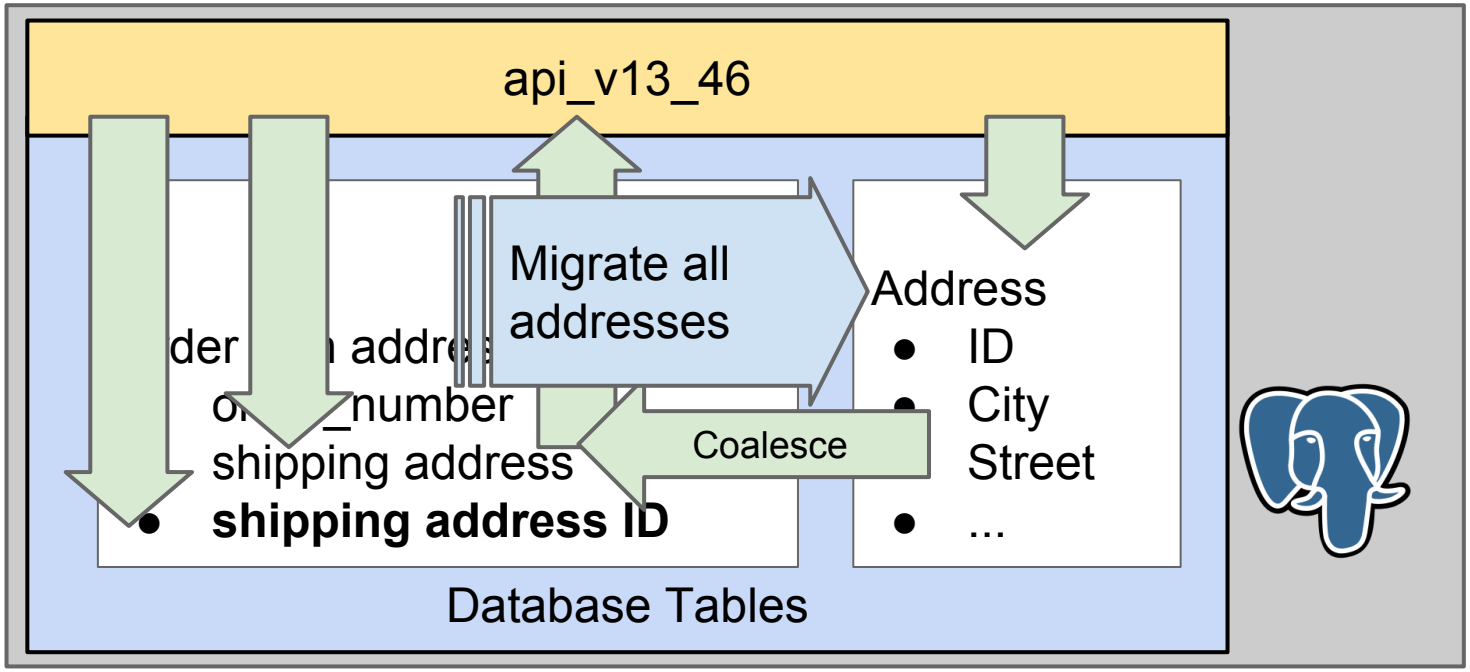
Read and write to old structure



Easy schema changes

search_path =
api_v13_46, public;

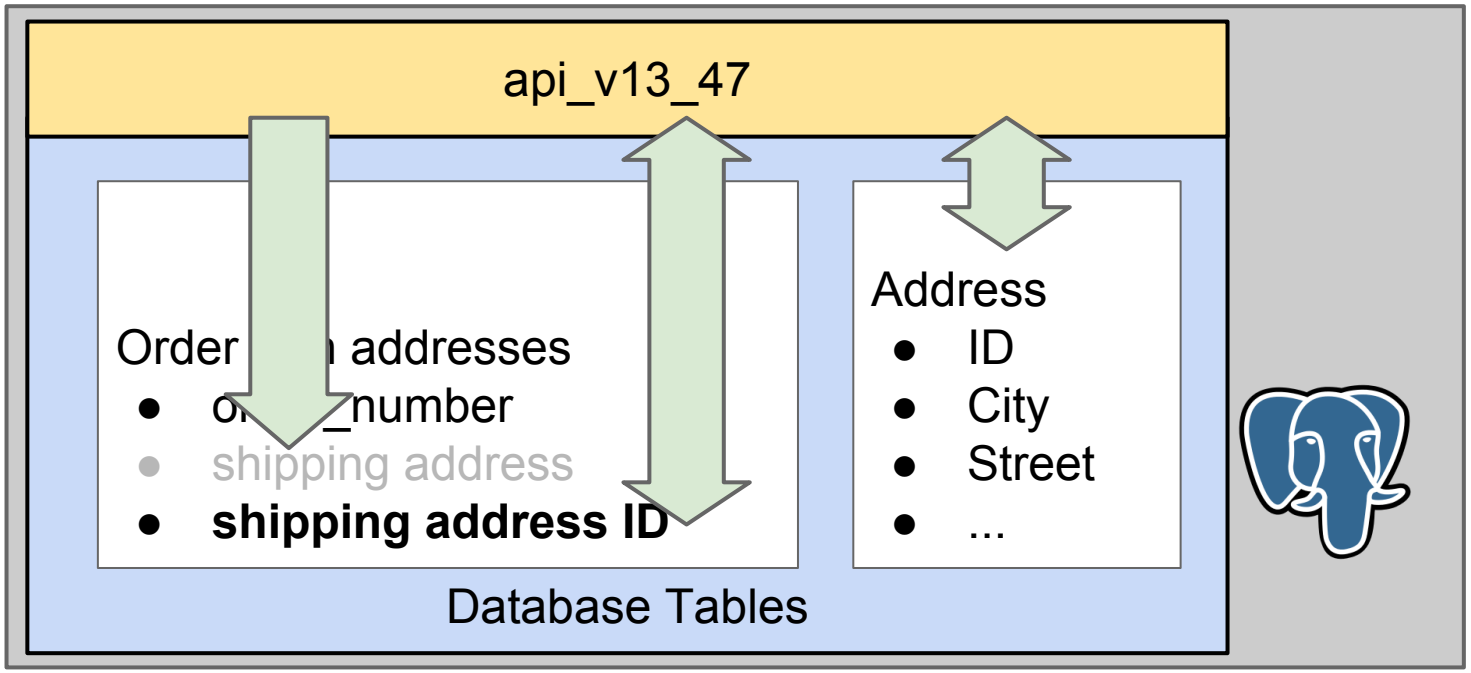
Write to both structures, old and new
Try to read from new, fallback to old



Easy schema changes

search_path =
api_v13_47, public;

Read from new
Write to both structures, old and new



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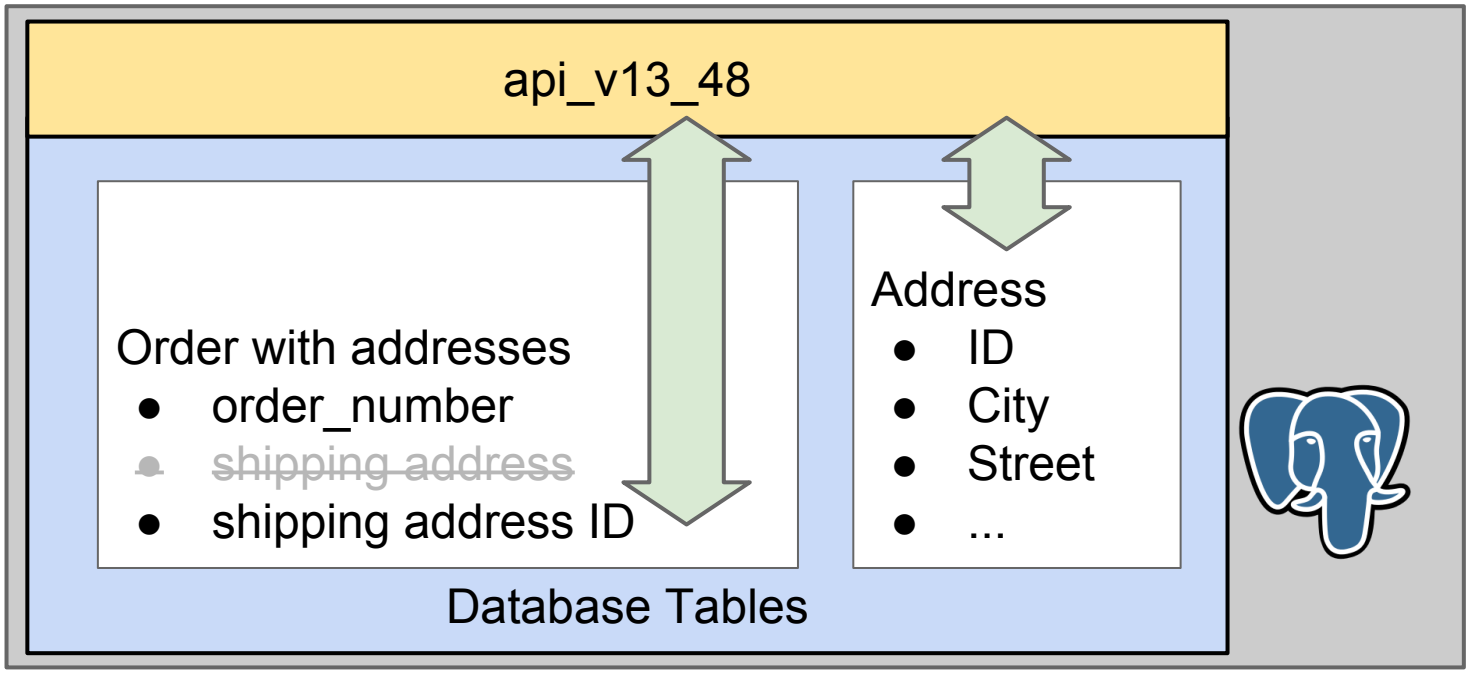
Easy schema changes

search_path =
api_v13_48, public;

Read and write to new
Drop old structures



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