PERCONA LIVE ONLINE MAY 12 - 13th 2021

JOING HETEROGENEOUS DATABASES IS A REALITY, NOT A MYTH

POSTGRESQL-FDW

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Who am I?

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Software Career

- Software industries since 1998.

PostgreSQL Career

- Working on PostgreSQL Since 2006.
- EnterpriseDB (Associate Software Architect core Database Engine) 2006-2009
- EnterpriseDB (Software Architect core Database Engine) 2011 - 2016
- EnterpriseDB (Senior Software Architect core Database Engine) 2016 – 2018
- Percona (Senior Software Architect core Database Engine) 2018 – Present

PostgreSQL Books

- PostgreSQL Developer's Guide
- PostgreSQL 9.6 High Performance

01 Application Architecture

02 SQL-MED

03 FDW Example

04 Push Down

05 Connection Pooling

06 Questions and Answers

Timeline

Application Architecture

FDW-Example

Push Down

Question Answers

5 Minutes	10 Minutes	15 Minutes	5 Minutes	5 Minutes	5 Minutes	5 Minutes

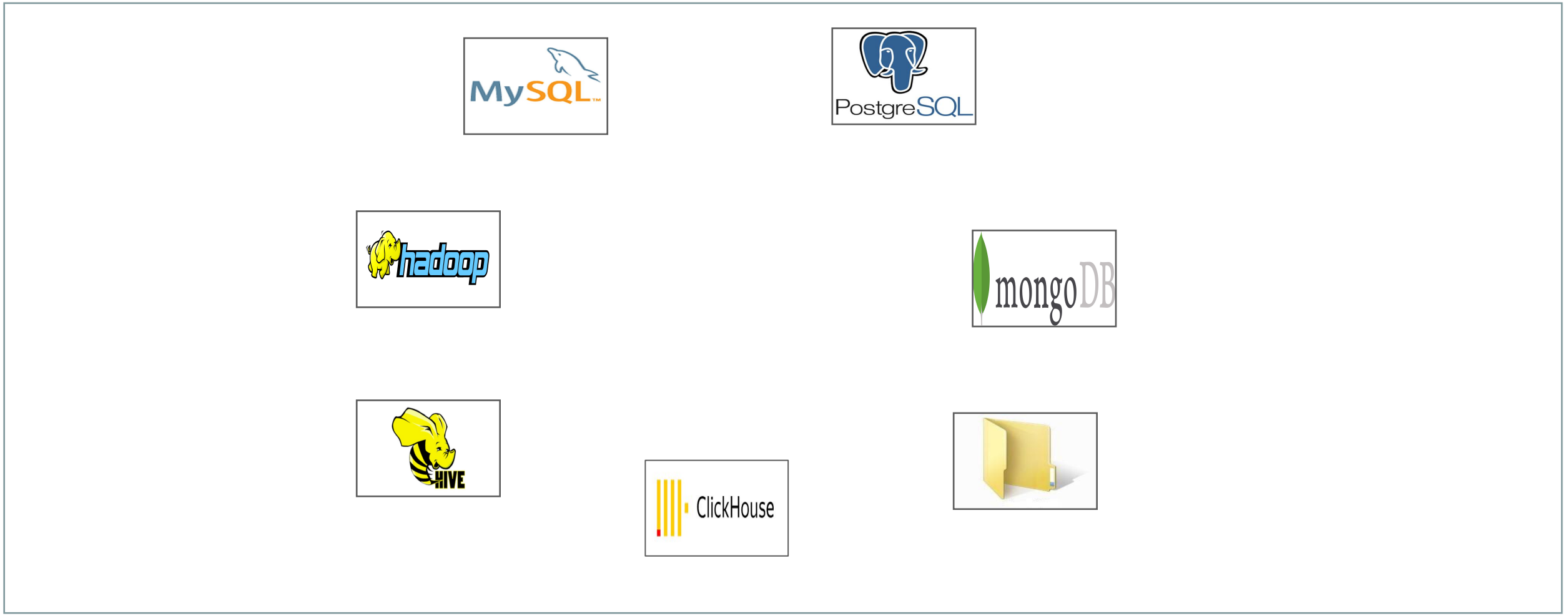
SQL-MED

DML

Connection Pooling

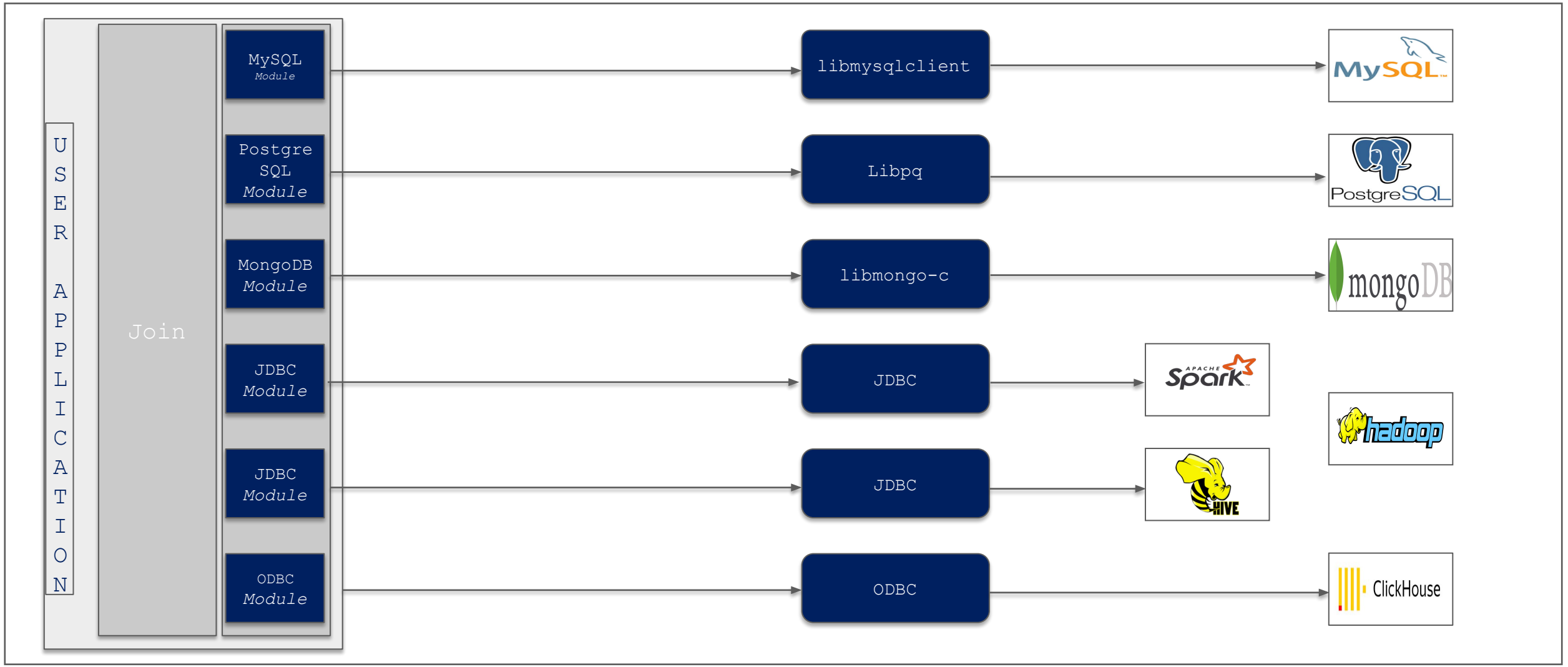
Why? Accessing Data From Multiple Sources

`SELECT * from multiple "Database Engines" and generate results?`



1.
Application Architecture

Application Architecture



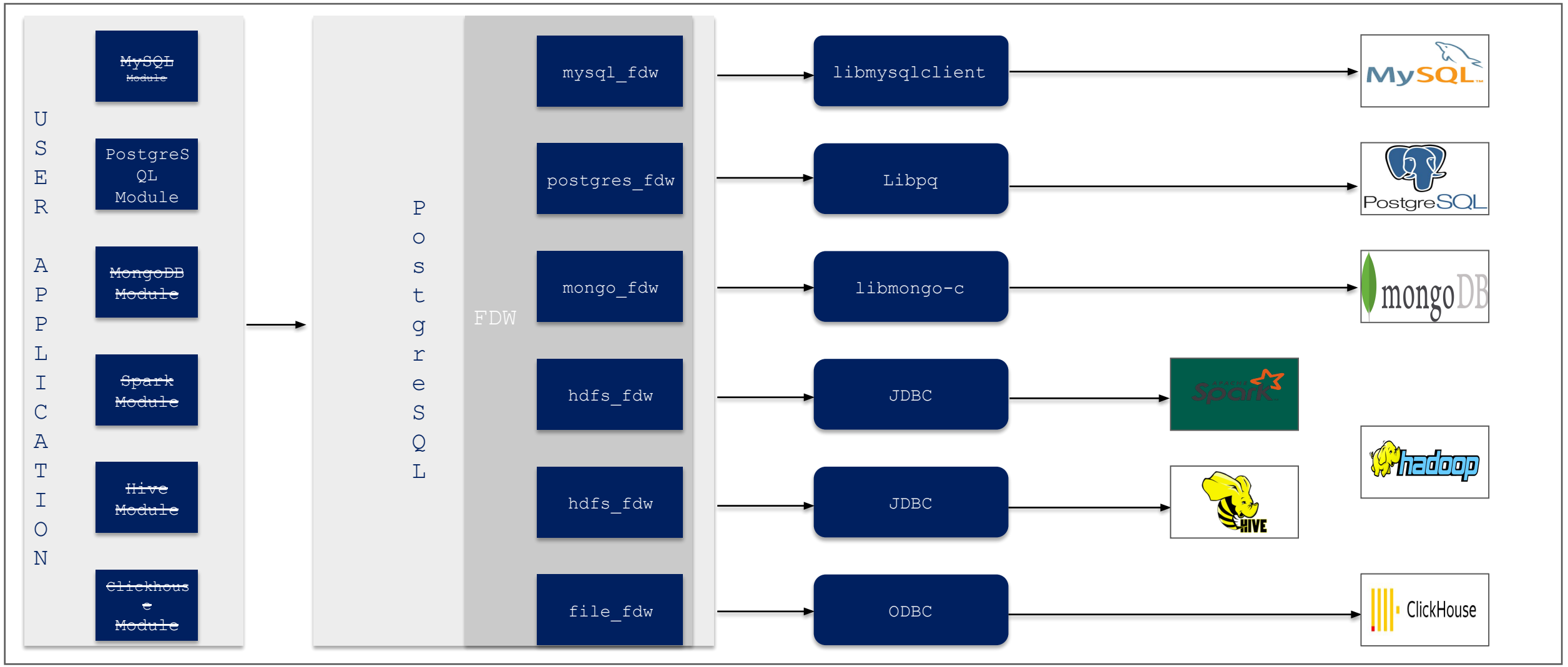
SQL-MED - Management of External Data

- SQL standard, it is defined by ISO/IEC 9075-9:2008
- SQL/MED provides extensions to SQL that define FDW (Foreign Data Wrapper)
- PostgreSQL start implementing in its core since PostgreSQL Version 9.1
- PostgreSQL community builds PostgreSQL FDW called postgresql_fdw

Now there are many FDWs implemented by other people

https://wiki.postgresql.org/wiki/Foreign_data_wrappers

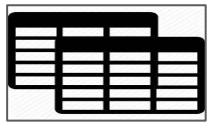
Application Architecture



2.
FDW-Example

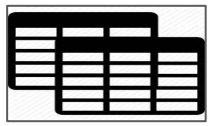
Example

US States / Cities



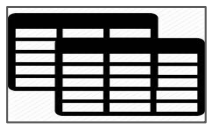
pg_tbl_states

Countries / Country



mysql_tbl_continents
mysql_tbl_countries

Flight Information



clickhouse_tbl_ontime

Setup: mysqldb_fdw (MySQL)

```
CREATE EXTENSION mysqldb_fdw;
```

```
CREATE SERVER mysql_svr
       FOREIGN DATA WRAPPER mysqldb_fdw
       OPTIONS (host '127.0.0.1',
                port '3306')
```

```
CREATE USER MAPPING FOR postgres
                    SERVER mysql_svr
       OPTIONS (username 'mysql_user', password  'mysql_pass');
```

```
CREATE FOREIGN TABLE mysql_tbl_continents
(
    code     VARCHAR(2),
    name     VARCHAR(255)
) SERVER mysql_svr OPTIONS(dbname 'db');
```

```
CREATE FOREIGN TABLE mysql_tbl_countries
(
       code            VARCHAR(2),
       name            VARCHAR(255),
       full_name       VARCHAR(255),
       iso3            CHAR(3),
       number          INTEGER,
       continent_code  VARCHAR(2)
) SERVER mysql_svr OPTIONS (dbname 'db');
```

Setup: clickhousedb_fdw (ClickHouse)

```
CREATE EXTENSION clickhousedb_fdw;
```

```
CREATE SERVER clickhouse_svr
       FOREIGN DATA WRAPPER clickhousedb_fdw
       OPTIONS(dbname 'test_database',
               driver '/use/lib/libclickhouseodbc.so');
```

```
CREATE USER MAPPING FOR postgres
    SERVER clickhouse_svr
    OPTIONS (username 'clickhouse_user', password 'clickhouse_pass');
```

```
CREATE FOREIGN TABLE clickhouse_tbl_ontime(
    Year    INTEGER,
    Quarter INTEGER,
    Month   INTEGER,
    …
) SERVER clickhouse_svr OPTIONS (table_name 'ontime');
```

SELECT Data From MySQL Using mysqldb_fdw 1/2

```
postgres=# SELECT * FROM mysql_tbl_continents;
 code |     name
------+---------------
 AF   | Africa
 AN   | Antarctica
 AS   | Asia
 EU   | Europe
 NA   | North America
 OC   | Oceania
 SA   | South America
(7 rows)
```

Same table name exists in MySQL

Data comes from MySQL Database

```
postgres=# SELECT code, name, continent_code
FROM mysql_tbl_countries LIMIT 7;
 code |          name          | continent_code
------+------------------------+----------------
 AD   | Andorra                | EU
 AE   | United Arab Emirates   | AS
 AF   | Afghanistan            | AS
 AG   | Antigua and Barbuda    | NA
 AI   | Anguilla               | NA
 AL   | Albania                | EU
 AM   | Armenia                | AS
(7 rows)
```

SELECT Data From MySQL Using mysqldb_fdw 2/2

```
postgres=# SELECT country.code, country.name, continent.name
           FROM mysql_tbl_continents continent, mysql_tbl_countries country
           WHERE continent.code = country.continent_code LIMIT 3;

 code |     name      |  name
------+---------------+--------
 AO   | Angola        | Africa
 BF   | Burkina Faso  | Africa
 BI   | Burundi       | Africa
(3 rows)
```

Country name comes from mysql_tbl_countries table

SELECT Data From Clickhouse Using clickhousedb_fdw

```
postgres=# SELECT a."Year", c1/c2 as value
           FROM
          (SELECT "Year", count(*)*1000 as c1
           FROM clickhouse_tbl_ontime
           WHERE "DepDelay">10 GROUP BY "Year") a
         INNER JOIN
          (SELECT "Year", count(*) as c2
           FROM clickhouse_tbl_ontime GROUP BY "Year" ) b
         ON a."Year"=b."Year" LIMIT 3;
Year  | value
------+-----------
1987  | 199
1988  | 654182000
(2 rows)
```

Join ClickHouse, MySQL and PostgreSQL Using FDW

```
postgres=# SELECT "Year",pg.code,"OriginStateName", pg.country_code, my.name
           FROM clickhouse_tbl_ontime ch
           LEFT JOIN pg_tbl_states pg
           ON pg.name = ch."OriginStateName"
           LEFT JOIN mysql_tbl_countries my
           ON pg.country_code = my.code
           LIMIT 3;

Year  | code | OriginStateName | country_code | name
------+------+-----------------+--------------+-------------------------
2011  | MO   | Missouri        | US           | United States of America
2011  | MO   | Missouri        | US           | United States of America
2011  | MO   | Missouri        | US           | United States of America
(3 rows)
```

EXPLAIN: Join ClickHouse, MySQL and PostgreSQL

```
postgres=# EXPLAIN VERBOSE
               SELECT "Year", pg.code, "OriginStateName", pg.country_code,my.name
               FROM clickhouse_tbl_ontime ch
               LEFT JOIN pg_tbl_states pg ON pg.name = ch."OriginStateName"
               LEFT JOIN mysql_tbl_countries my ON pg.country_code = my.code limit 3;

                                        QUERY PLAN

-> Hash Right Join (cost=10.00..1900.21 rows=5000 width=558)
   Hash Cond: ((pg.name)::text = ch."OriginStateName")
     -> Nested Loop Left Join (cost=10.00..1899.09 rows=295 width=532)
    Join Filter: ((pg.country_code)::text = (my.code)::text)
           -> Seq Scan on public.pg_tbl_states pg (cost=0.00..1.59 rows=59 width=16)
           -> Materialize (cost=10.00..1015.00 rows=1000 width=528)
           -> Foreign Scan on public.mysql_tbl_countries my
                    (cost=10.00..1010.00 rows=1000 width=528)
                  Remote query: SELECT `code`, `name` FROM `db`.`mysql_tbl_countries`
    -> Hash (cost=0.00..0.00 rows=0 width=36)
          -> Foreign Scan on public.clickhouse_tbl_ontime ch
             (cost=0.00..0.00           rows=0 width=36)
            Output: ch."Year", ch."OriginStateName"
       Remote SQL: SELECT "Year", "OriginStateName" FROM "default".ontime
```

3.

Push Down

Push Down – A Performance Feature

- Operator and function push down
- Predicate push down
- Aggregate push down
- Join push down

PostgreSQL Foreign Data Wrapper - JOIN Push Down

```
postgres=# EXPLAIN (VERBOSE, COST off)
           SELECT * FROM postgres_tbl_name n
           RIGHT JOIN postgres_tbl_job j
           ON(j.name_id > n.id);

                                    QUERY PLAN
Foreign Scan
   Output: n.id, n.name, j.id, j.job_title, j.name_id
   Relations: (public.postgres_tbl_job j)
   LEFT JOIN (public.postgres_tbl_name n)

   Remote SQL: SELECT r2.id, r2.job_title, r2.name_id, r1.id, r1.name
               FROM (public.postgres_tbl_job r2
               LEFT JOIN public.postgres_tbl_name r1
               ON    (((r2.name_id > r1.id))))
(4 rows)
```

PostgreSQL Foreign Data Wrapper - Aggregate Push Down

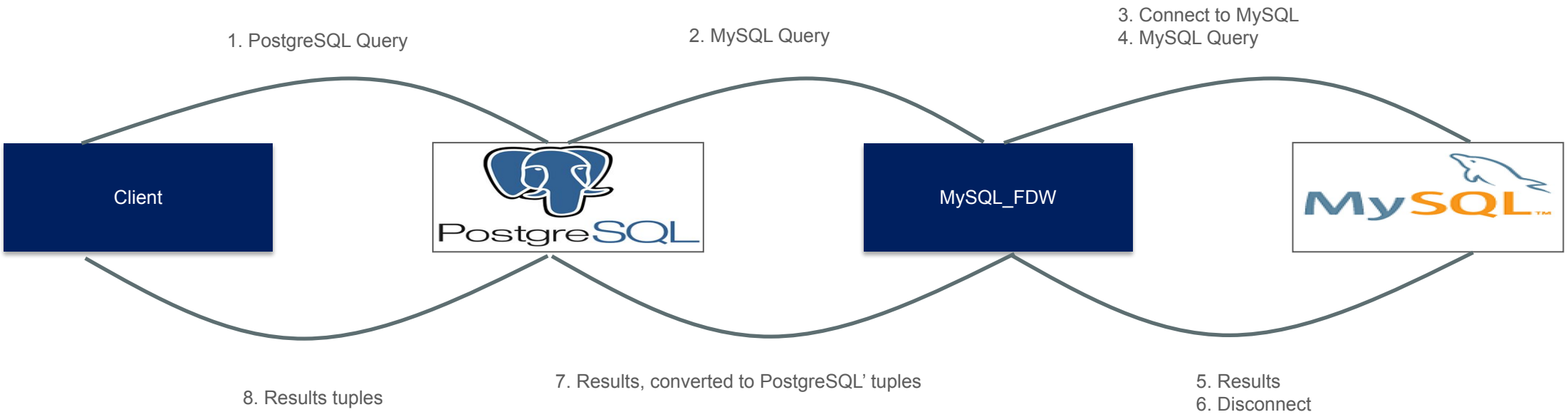
```
postgres=# EXPLAIN VERBOSE SELECT count(*) FROM postgres_tbl_name;
                            QUERY PLAN
-------------------------------------------------------------
 Foreign Scan  (cost=108.53..152.69 rows=1 width=8)
   Output: (count(*))
   Relations: Aggregate on (public.postgres_tbl_name)
   Remote SQL: SELECT count(*) FROM public.postgres_tbl_name
(4 rows)
```

```
postgres=# EXPLAIN VERBOSE SELECT count(*) FROM mysql_tbl_continents;
                                        QUERY PLAN
-------------------------------------------------------------------------------------
 Aggregate  (cost=1012.50..1012.51 rows=1 width=8)
   Output: count(*)
   ->  Foreign Scan on public.mysql_tbl_continents  (cost=10.00..1010.00 rows=1000 width=0)
         Output: continent_id, continent_name
         Local server startup cost: 10
         Remote query: SELECT NULL FROM `db`.`mysql_tbl_continents`
(6 rows)
```

4.

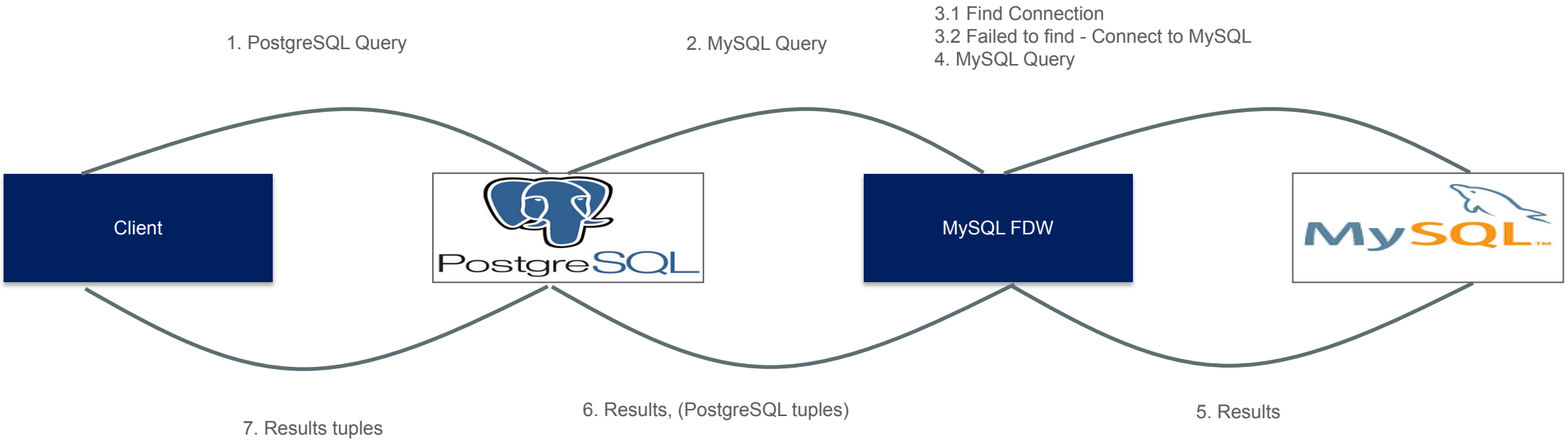
Connection Pooling

Connections 1/2



Do we really need to Disconnect / Connect on each query?

Connections 2/2



DML Support

- PostgreSQL has DML support
- There are several Foreign Data Wrappers that support DML such as:
  - postgres_fdw
  - mysql_fdw
  - oracle_fdw

Questions?

“Poor leaders rarely ask questions of themselves or others. Good leaders, on the other hand, ask many questions. Great leaders ask the great questions.”

Michael Marquardt author of Leading with Questions