Making Postgres Central in Your Data Center

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This talk explores why Postgres is uniquely capable of functioning as a central database in enterprises. *Title concept from Josh Berkus*

https://momjian.us/presentations

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Outline

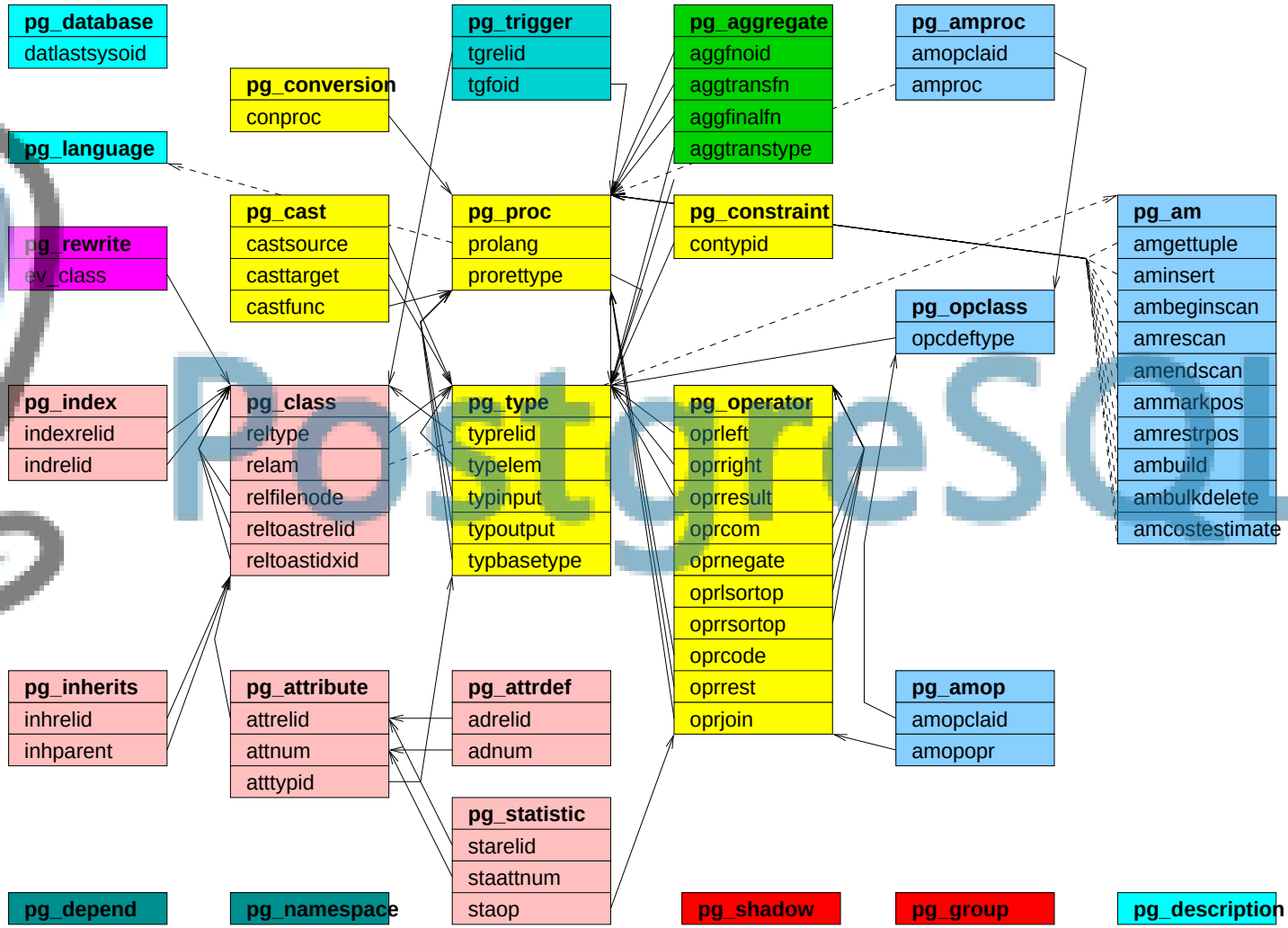
1. Object-relational (extensibility)
2. NoSQL
3. Data analytics
4. Foreign data wrappers (database federation)
5. Central role

1. Object-Relational (Extensibility)

Object-relational databases like Postgres support classes and inheritance, but most importantly, they define database functionality as objects that can be easily manipulated.

http://en.wikipedia.org/wiki/Object-relational_database

How Is this Accomplished?



http://www.postgresql.org/docs/current/catalogs.html

Example: ISBN Data Type

```
CREATE EXTENSION isn;

\dT
                          List of data types
 Schema |  Name   |                      Description
--------+---------+-------------------------------------------------
 public | ean13   | International European Article Number (EAN13)
 public | isbn    | International Standard Book Number (ISBN)
 public | isbn13  | International Standard Book Number 13 (ISBN13)
 public | ismn    | International Standard Music Number (ISMN)
 public | ismn13  | International Standard Music Number 13 (ISMN13)
 public | issn    | International Standard Serial Number (ISSN)
 public | issn13  | International Standard Serial Number 13 (ISSN13)
 public | upc     | Universal Product Code (UPC)
```

http://www.postgresql.org/docs/current/isn.html

ISBN Behaves Just Like Built-In Types

```
\dTS
…
 pg_catalog | integer  | -2 billion to 2 billion integer, 4-byte storage
…
 public     | isbn     | International Standard Book Number (ISBN)
```

The System Catalog Entry for INTEGER

```
SELECT * FROM pg_type WHERE typname = 'int4';
-[ RECORD 1 ]--+---------
typname        | int4
typnamespace   | 11
typowner       | 10
typlen         | 4
typbyval       | t
typtype        | b
typcategory    | N
typispreferred | f
typisdefined   | t
typdelim       | ,
typrelid       | 0
typelem        | 0
typarray       | 1007
typinput       | int4in
typoutput      | int4out
typreceive     | int4recv
typsend        | int4send
typmodin       | -
typmodout      | -
typanalyze     | -
…
```


http://www.postgresql.org/docs/current/catalog-pg-type.html

The System Catalog Entry for ISBN

```
SELECT * FROM pg_type WHERE typname = 'isbn';
-[ RECORD 1 ]--+---------------
typname        | isbn
typnamespace   | 2200
typowner       | 10
typlen         | 8
typbyval       | t
typtype        | b
typcategory    | U
typispreferred | f
typisdefined   | t
typdelim       | ,
typrelid       | 0
typelem        | 0
typarray       | 16405
typinput       | isbn_in
typoutput      | public.isn_out
typreceive     | -
typsend        | -
typmodin       | -
typmodout      | -
typanalyze     | -
…
```

Not Just Data Types, Languages

```
CREATE EXTENSION plpythonu;

\dL
                                List of languages
   Name    |  Owner   | Trusted |                Description
-----------+----------+---------+------------------------------------
 plpgsql   | postgres | t       | PL/pgSQL procedural language
 plpythonu | postgres | f       | PL/PythonU untrusted procedural language
```

http://www.postgresql.org/docs/current/plpython.html

Available Languages

- PL/Java
- PL/Perl
- PL/pgSQL (like PL/SQL)
- PL/PHP
- PL/Python
- PL/R (like SPSS)
- PL/Ruby
- PL/Scheme
- PL/sh
- PL/Tcl
- PL/v8 (JavaScript)
- SPI (C)

http://www.postgresql.org/docs/current/external-pl.html

Specialized Indexing Methods

- BRIN
- BTree
- Hash
- GIN (generalized inverted index)
- GiST (generalized search tree)
- SP-GiST (space-partitioned GiST)

http://www.postgresql.org/docs/current/indexam.html

Index Types Are Defined in the System Catalogs Too

```
SELECT amname FROM pg_am ORDER BY 1;
 amname
--------
 brin
 btree
 hash
 gin
 gist
 spgist
```


http://www.postgresql.org/docs/current/catalog-pg-am.html

Operators Have Similar Flexibility

Operators are function calls with left and right arguments of specified types:

```
\doS
   Schema   | Name | Left arg type | Right arg type | Result type | Description
…
 pg_catalog | +    | integer       | integer        | integer     | add

\dfS
   Schema   | Name   | Result data type | Argument data types |  Type
…
 pg_catalog | int4pl | integer          | integer, integer    | normal
```

Other Extensibility

- Aggregates are defined in pg_aggregate, sum(int4)
- Casts are defined in pg_cast, int4(float8)

Externally Developed Plug-Ins

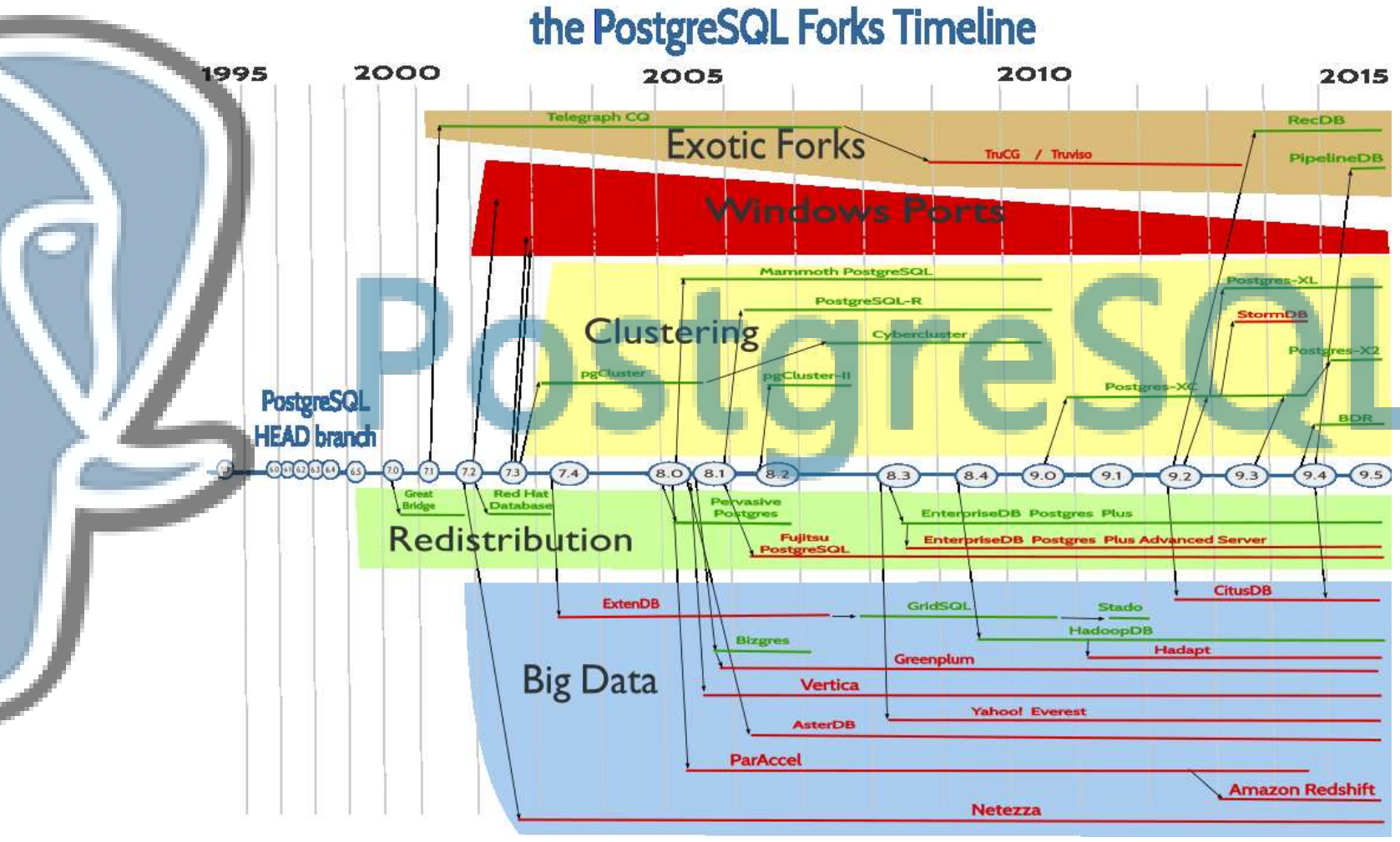
- PostGIS (Geographical Information System)
- PL/v8 (server-side JavaScript)
- experimentation, e.g., full text search was originally externally developed

Offshoots of Postgres

- Aurora (Amazon)
- AsterDB
- Greenplum
- Informix
- Netezza
- ParAccel
- Postgres XC
- Redshift (Amazon)
- Truviso
- Vertica
- Yahoo! Everest

https://wiki.postgresql.org/wiki/PostgreSQL_derived_databases
http://de.slideshare.net/pgconf/elephant-roads-a-tour-of-postgres-forks

Offshoots of Postgres

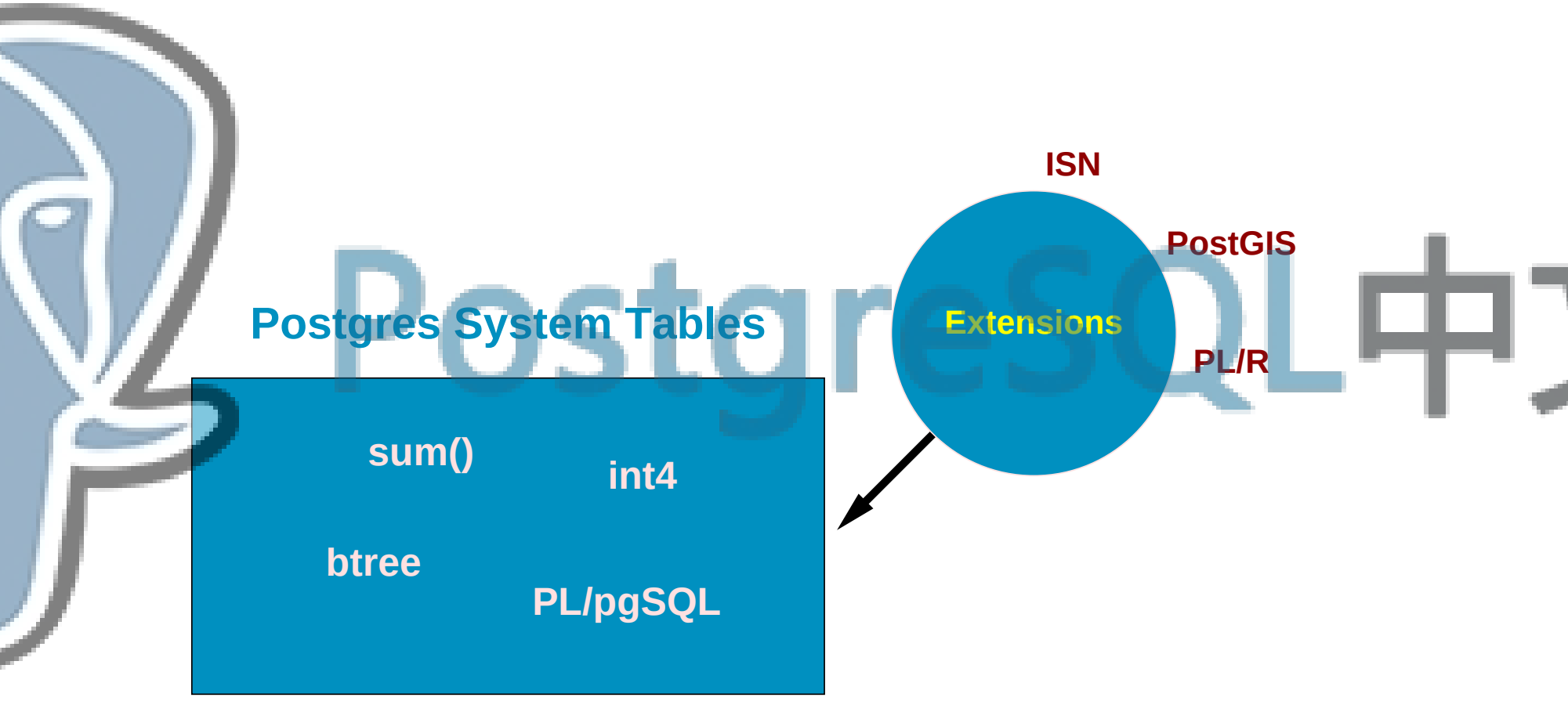


https://raw.github.com/daamien/artwork/master/inkscape/PostgreSQL_timeline/timeline_postgresql.png

Plug-In Is Not a Bad Word

Many databases treat extensions as special cases, with serious limitations. Postgres built-ins use the same API as extensions, so ll extensions operate just like built-in functionality.

Extensions and Built-In Facilities Behave the Same

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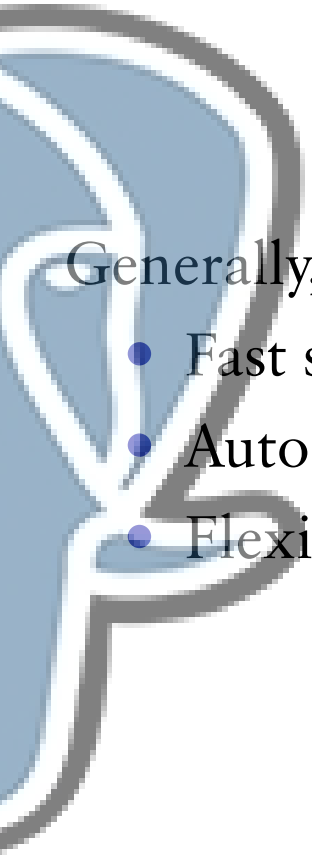
NoSQL Types

There is no single NoSQL technology. They all take different approaches and have different features and drawbacks:

- Key-value stores, e.g., Redis
- Document databases, e.g., MongoDB (JSON)
- Columnar stores: Cassandra
- Graph databases: Neo4j

Why NoSQL Exists



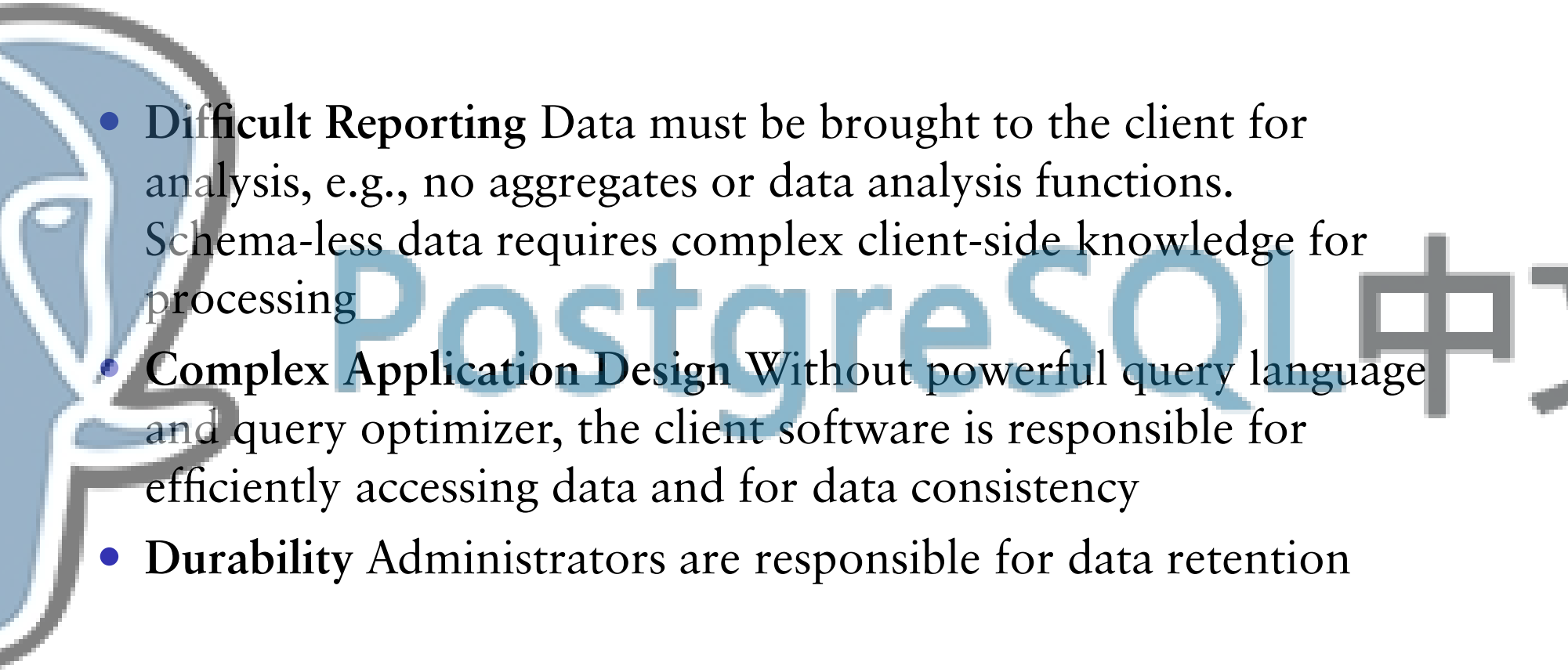
Generally, NoSQL is optimized for:

- Fast simple queries
- Auto-sharding
- Flexible schemas

NoSQL Sacrifices

- A powerful query language
- A sophisticated query optimizer
- Data normalization
- Joins
- Referential integrity
- Durability

Are These Drawbacks Worth the Cost?



- **Difficult Reporting** Data must be brought to the client for analysis, e.g., no aggregates or data analysis functions. Schema-less data requires complex client-side knowledge for processing
- **Complex Application Design** Without powerful query language and query optimizer, the client software is responsible for efficiently accessing data and for data consistency
- **Durability** Administrators are responsible for data retention

When Should NoSQL Be Used?

- Massive write scaling is required, more than a single server can provide
- Only simple data access pattern is required
- Additional resource allocation for development is acceptable
- Strong data retention or transactional guarantees are not required
- Unstructured duplicate data that greatly benefits from column compression

When Should Relational Storage Be Used?

- Easy administration
- Variable workloads and reporting
- Simplified application development
- Strong data retention

The Best of Both Worlds: Postgres

Postgres has many NoSQL features without the drawbacks:

- Schema-less data types, with sophisticated indexing support
- Transactional schema changes with rapid additional and removal of columns
- Durability by default, but controllable per-table or per-transaction

Schema-Less Data: JSONB

```
CREATE TABLE customer (id SERIAL, data JSONB);

INSERT INTO customer VALUES (DEFAULT, '{"name" : "Bill", "age" : 21}');

SELECT data->'name' FROM customer WHERE data->>'age' = '21';
 ?column?
----------
 "Bill"
```

Easy Relational Schema Changes

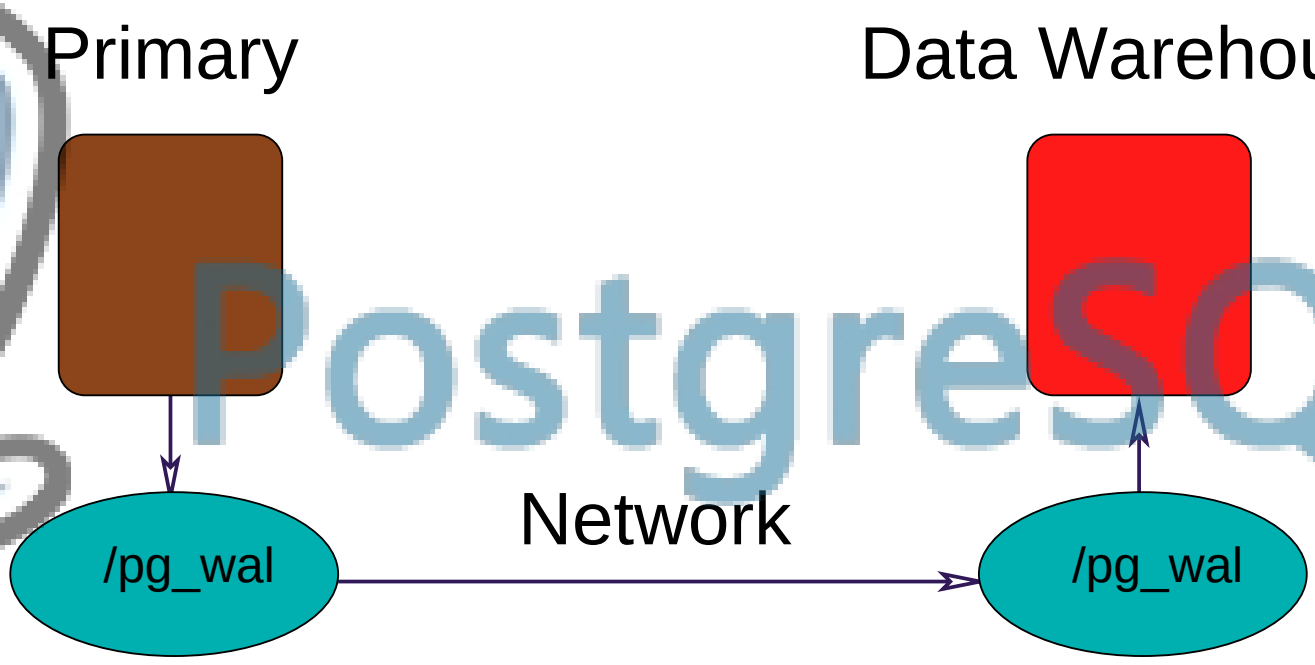
```
BEGIN WORK;
ALTER TABLE customer ADD COLUMN debt_limit NUMERIC(10,2);
ALTER TABLE customer ADD COLUMN creation_date TIMESTAMP WITH TIME ZONE;
ALTER TABLE customer RENAME TO cust;
COMMIT;
```

3. Data Analytics

- Aggregates
- Optimizer
- Server-side languages, e.g., PL/R
- Window functions
- Bitmap heap scans
- Tablespaces
- Data partitioning
- Materialized views
- Common table expressions (CTE)
- BRIN indexes
- GROUPING SETS, ROLLUP, CUBE
- Just-in-time compilation (JIT)
- Parallelism
- Sharding (in progress)

http://www.slideshare.net/PGExperts/really-big-elephants-postgresql-dw-15833438
http://wiki.postgresql.org/images/3/38/PGDay2009-EN-Datawarehousing_with_PostgreSQL.pdf

Read-Only Slaves for Analytics



Tables from multiple clusters can be collected and synchronized on one cluster using logical replication, and a single table can be broadcast to multiple clusters too.

4. Foreign Data Wrappers (Database Federation)

Foreign data wrappers (SQL MED) allow queries to read and write data to foreign data sources. Foreign database support includes:

- CouchDB
- Informix
- MongoDB
- MySQL
- Neo4j
- Oracle
- Postgres
- Redis

The transfer of joins, aggregates, and sorts to foreign servers is not yet implemented.

http://www.postgresql.org/docs/current/ddl-foreign-data.html
http://wiki.postgresql.org/wiki/Foreign_data_wrappers

Foreign Data Wrappers to Interfaces

- JDBC
- ODBC
- LDAP

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Foreign Data Wrappers to Non-Traditional Data Sources

- Files
- HTTP
- AWS S3
- Twitter

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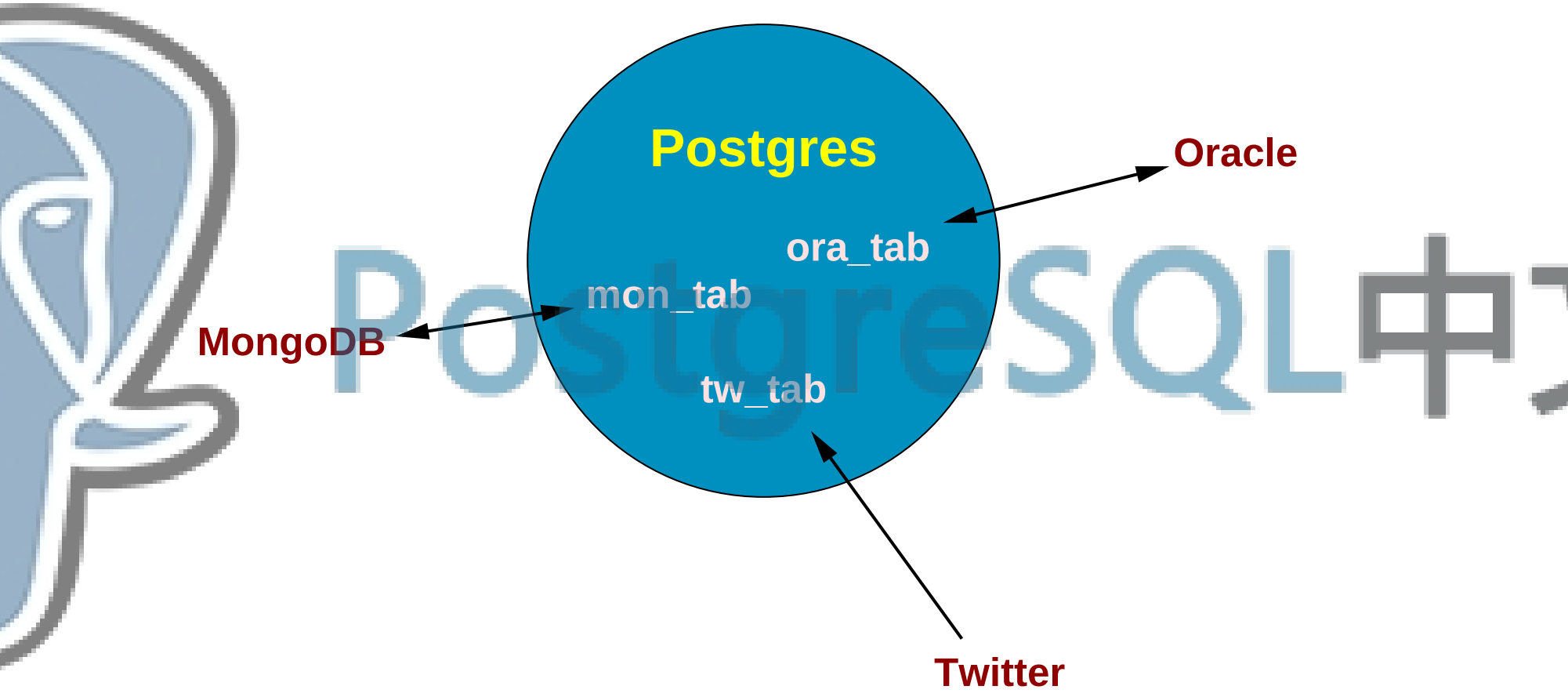
Foreign Data Wrapper Example

```
CREATE SERVER postgres_fdw_test
FOREIGN DATA WRAPPER postgres_fdw
OPTIONS (host 'localhost', dbname 'fdw_test');


CREATE USER MAPPING FOR PUBLIC
SERVER postgres_fdw_test
OPTIONS (password '');


CREATE FOREIGN TABLE other_world (greeting TEXT)
SERVER postgres_fdw_test
OPTIONS (table_name 'world');


\det
List of foreign tables
Schema | Table | Server
--------+-------------+------------------
public | other_world | postgres_fdw_test
```

Foreign Postgres server name in red; foreign table name in blue

Read and Read/Write Data Sources



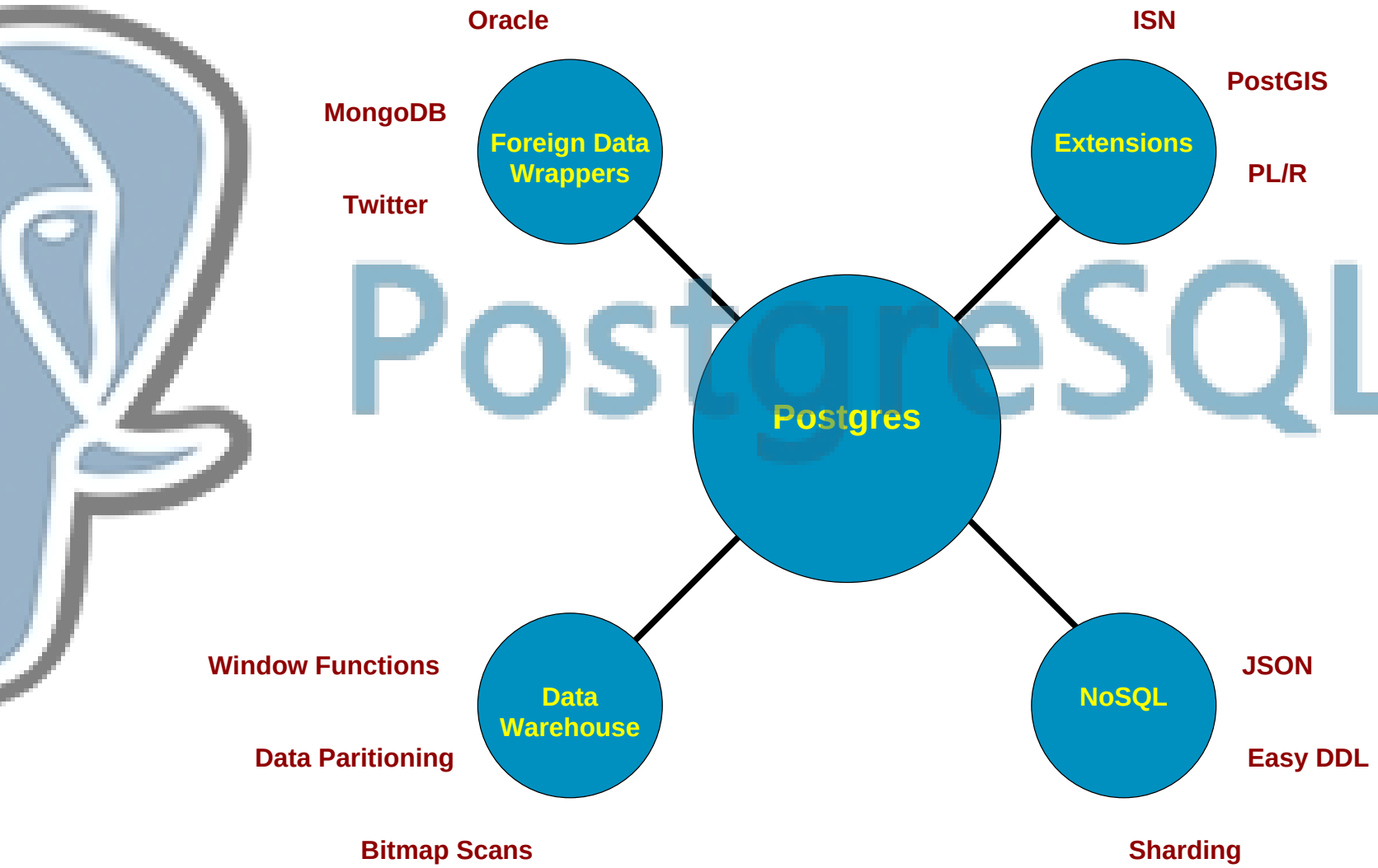
5. Postgres Centrality

Postgres can rightly take a central place in the data center with its:

- Object-relation flexibility and extensibility
- NoSQL-like workloads
- Powerful data analytics capabilities
- Access to foreign data sources

No other database has all of these key components.

Postgres's Central Role



Conclusion

https://momjian.us/presentations

https://www.flickr.com/photos/kenny_barker/