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Data Community Summit

Working With PostgreSQL as a JSON Document Store

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Howdy!

Who am I?

Howdy!

Who RU?

Make Sense of Your Database

About This Talk

- **Part I: An Overview of PostgreSQL JSON**
- **Part II: Scenarios**

Make Sense of Your Database

PART I: An Overview of PostgreSQL JSON

Some Definitions

1) DBMS
2) RDBMS
3) GPDBMS

PostgreSQL: General Purpose Database Management System

- Relational (structured)
  - row wise: OLTP
  - column wise: OLAP
  - data warehouse
  - analytics
- Unstructured
  - hash
  - hierarchical
  - document storage
- High Availability (HA)
  - logical backups
  - clustered, across nodes ex: replication
- High Performance (HP)
  1) clustered ex: horizontal scaling
  - sharding with data redundancies
- Embedded (application centric)
- Big Data (inter/intra data centres)
- Encrypted
  - session
  - data
  - at rest (encrypted discs)

About JSON

Unstructured data files often include text and multimedia content. Examples include e-mail messages, word processing documents, videos, photos, audio files, presentations, webpages, and many other kinds of business documents.

JSON (JavaScript Object Notation) is a lightweight data-interchange format. It is easy for humans to read and write. It is easy for machines to parse and generate. It is based on a subset of the JavaScript Programming Language Standard ECMA-262 3rd Edition - December 1999.

JSON is a text format that is completely language independent but uses conventions that are familiar to programmers of the C-family of languages, including C, C++, C#, Java, JavaScript, Perl, Python, and many others. These properties make JSON an ideal data-interchange language.

http://www.ecma-international.org/publications/files/ECMA-ST/ECMA-404.pdf

About the PostgreSQL Implementation of JSON

1) **Data Types**
2) **Indexes**
3) **JSON Path Type**
4) **Operators**
5) **Functions**

Data Types

```
create table mytable (
   id     integer primary key generated by default as identity,
   mydoc   json,
   mydocb  jsonb
);
```

```
                          Table "public.mytable"
 Column |  Type    | Collation | Nullable |             Default
--------+----------+-----------+----------+---------------------------------
 id     | integer |           | not null | generated by default as identity
 mydoc  | json    |           |          |
 mydocb | jsonb   |           |          |
Indexes:
    "mytable_pkey" PRIMARY KEY, btree (id)
```

https://www.postgresql.org/docs/current/datatype-json.html

Example: Simple Scalar/Primitive Values

```
-- Primitive values can be numbers, quoted strings, true, false, or null
SELECT '5'::json;

-- Array of zero or more elements (elements need not be of same type)
SELECT '[1, 2, "foo", null]'::json;

-- Object containing pairs of keys and values
-- Note that object keys must always be quoted strings
SELECT '{"bar": "baz", "balance": 7.77, "active": false}'::json;

-- Arrays and objects can be nested arbitrarily
SELECT '{"foo": [true, "bar"], "tags": {"a": 1, "b": null}}'::json;
```

Example: JSONB Containment and Existence

```
-- Simple scalar/primitive values contain only the identical value:
SELECT '"foo"'::jsonb @> '"foo"'::jsonb;

-- The array on the right side is contained within the one on the left:
SELECT '[1, 2, 3]'::jsonb @> '[1, 3]'::jsonb;

-- Order of array elements is not significant, so this is also true:
SELECT '[1, 2, 3]'::jsonb @> '[3, 1]'::jsonb;

-- Duplicate array elements don't matter either:
SELECT '[1, 2, 3]'::jsonb @> '[1, 2, 2]'::jsonb;

-- The object with a single pair on the right side is contained
-- within the object on the left side:
SELECT '{"product": "PostgreSQL", "version": 9.4, "jsonb": true}'::jsonb @> '{"version": 9.4}'::jsonb;

-- The array on the right side is not considered contained within the
-- array on the left, even though a similar array is nested within it:
SELECT '[1, 2, [1, 3]]'::jsonb @> '[1, 3]'::jsonb;  -- yields false

-- But with a layer of nesting, it is contained:
SELECT '[1, 2, [1, 3]]'::jsonb @> '[[1, 3]]'::jsonb;

-- Similarly, containment is not reported here:
SELECT '{"foo": {"bar": "baz"}}'::jsonb @> '{"bar": "baz"}'::jsonb;  -- yields false

-- A top-level key and an empty object is contained:
SELECT '{"foo": {"bar": "baz"}}'::jsonb @> '{"foo": {}}'::jsonb;
```

Indexes

```
create table mytable (
   id     integer primary key generated by default as identity,
   mydoc   json,
   mydocb  jsonb
);

-- only JSONB
create index on mytable using gin (mydocb);
```

```
                          Table "public.mytable"
 Column |  Type   | Collation | Nullable |             Default
--------+---------+-----------+----------+---------------------------------
 id     | integer |           | not null | generated by default as identity
 mydoc  | json    |           |          |
 mydocb | jsonb   |           |          |
Indexes:
    "mytable_pkey" PRIMARY KEY, btree (id)
    "mytable_mydocb_idx" gin (mydocb)
```

Example


```
{
    "guid": "9c36adc1-7fb5-4d5b-83b4-90356a46061a",
    "name": "Angela Barton",
    "is_active": true,
    "company": "Magnafone",
    "address": "178 Howard Place, Gulf, Washington, 702",
    "registered": "2009-11-07T08:53:22 +08:00",
    "latitude": 19.793713,
    "longitude": 86.513373,
    "tags": [
        "enim",
        "aliquip",
        "qui"
    ]
}
```

Example, cont’d

```
--
-- Find documents in which the key "company" has value "Magnafone"
-- Does the left JSON value contain the right
–  JSON path/value entries at the top level?
--
tmp=# EXPLAIN
tmp-# SELECT mydocb->'guid', mydocb->'name'
tmp-# FROM mytable
tmp-# WHERE mydocb @> '{"company": "Magnafone"}';
                        QUERY PLAN
-----------------------------------------------------------
 Seq Scan on mytable  (cost=0.00..20.63 rows=1 width=64)
   Filter: (mydocb @> '{"company": "Magnafone"}'::jsonb)
```

Example, cont'd

```
tmp=# create index on mytable using gin ((mydocb -> 'tags'));
--
tmp=# EXPLAIN
tmp-# SELECT mydocb->'guid', mydocb->'name'
tmp-# FROM mytable
tmp-# WHERE mydocb @> '{"company": "Magnafone"}';
                                  QUERY PLAN
-------------------------------------------------------------------------------
 Bitmap Heap Scan on mytable  (cost=12.01..16.02 rows=1 width=64)
   Recheck Cond: (mydocb @> '{"company": "Magnafone"}'::jsonb)
   ->  Bitmap Index Scan on mytable_mydocb_idx  (cost=0.00..12.01 rows=1 width=0)
         Index Cond: (mydocb @> '{"company": "Magnafone"}'::jsonb)
```

JSON Path Type

The jsonpath type implements support for the SQL/JSON path language.

Semantics:

- Dot (.) is used for member access.
- Square brackets ([]) are used for array access.
- SQL/JSON arrays are 0-relative, unlike regular SQL arrays that start from 1.

https://www.postgresql.org/docs/current/datatype-json.html
https://www.postgresql.org/docs/current/functions-json.html

Operators

EXAMPLE: (Operator ->)

Get JSON array element
(indexed from zero, negative integers count from the end)

```
SELECT '[{"a":"foo"},{"b":"bar"},{"c":"baz"}]'::json->2 as "operator ->";

 operator ->
-------------
 {"c":"baz"}
```

Operators: JSON and JSONB

Operator	Example	Example Result
->	'[{"a":"foo"},{"b":"bar"},{"c":"baz"}]'::json->2	{"c":"baz"}
->	'{"a": {"b":"foo"}}'::json->'a'	{"b":"foo"}
->>	'[1,2,3]'::json->>2	3
->>	'{"a":1,"b":2}'::json->>'b'	2
#>	'{"a": {"b":{"c": "foo"}}}'::json#>'{a,b}'	{"c": "foo"}
#>>	'{"a":[1,2,3],"b":[4,5,6]}'::json#>>'{a,2}'	3
@>	'{"a":1, "b":2}'::jsonb @> '{"b":2}'::jsonb	t
<@	'{"b":2}'::jsonb <@ '{"a":1, "b":2}'::jsonb	t
?	'{"a":1, "b":2}'::jsonb ? 'b'	t
?|	'{"a":1, "b":2, "c":3}'::jsonb ?| array['b', 'c']	t
?&	'["a", "b"]'::jsonb ?& array['a', 'b']	t
||	'["a", "b"]'::jsonb || '["c", "d"]'::jsonb	["a", "b", "c", "d"]
-	'{"a": "b"}'::jsonb - 'a'	{}
-	'{"a": "b", "c": "d"}'::jsonb - '{a,c}'::text[]	{}
-	'["a", "b"]'::jsonb - 1	["a"]
#-	'["a", {"b":1}]'::jsonb #- '{1,b}'	["a", {}]
@?	'{"a":[1,2,3,4,5]}'::jsonb @? '$.a[*] ? (@ > 2)'	t
@@	'{"a":[1,2,3,4,5]}'::jsonb @@ '$.a[*] > 2'	t

Operators: JSONB only

Operator	Details
<	less than
>	greater than
<=	less than or equal to
>=	greater than or equal to
=	equal
<> or !=	not equal

Functions

```
SELECT to_json('Fred said "Hi."'::text);
       to_json
---------------------
 "Fred said \"Hi.\""

SELECT array_to_json('{{1,5},{99,100}}'::int[]);
  array_to_json
-------------------
 [[1,5],[99,100]]

SELECT * FROM json_each('{"a":"foo", "b":"bar"}');

 key | value
-----+-------
 a   | "foo"
 b   | "bar"
```

Functions Cont'd

row_to_json(row(1,'foo'))	{"f1":1,"f2":"foo"}
json_build_array(1,2,'3',4,5)	[1, 2, "3", 4, 5]
json_build_object('foo',1,'bar',2)	{"foo": 1, "bar": 2}
json_object('{a, 1, b, "def", c, 3.5}') json_object('{{a, 1},{b, "def"},{c, 3.5}}')	{"a": "1", "b": "def", "c": "3.5"}
json_object('{a, b}', '{1,2}')	{"a": "1", "b": "2"}
json_array_length('[1,2,3,{"f1":1,"f2":[5,6]},4]')	5

Functions Cont'd

json_extract_path(from_json json, VARIADIC path_elems text[]) jsonb_extract_path(from_json jsonb, VARIADIC path_elems text[])
json_extract_path_text(from_json json, VARIADIC path_elems text[]) jsonb_extract_path_text(from_json jsonb, VARIADIC path_elems text[])
json_object_keys(json) jsonb_object_keys(jsonb)
json_populate_record(base anyelement, from_json json) jsonb_populate_record(base anyelement, from_json jsonb)
json_populate_recordset(base anyelement, from_json json) jsonb_populate_recordset(base anyelement, from_json jsonb)
json_array_elements(json) jsonb_array_elements(jsonb)
json_array_elements_text(json) jsonb_array_elements_text(jsonb)
json_typeof(json) jsonb_typeof(jsonb)
json_to_record(json) jsonb_to_record(jsonb)
json_to_recordset(json) jsonb_to_recordset(jsonb)
json_strip_nulls(from_json json) jsonb_strip_nulls(from_json jsonb)
jsonb_set(target jsonb, path text[], new_value jsonb [, create_missing boolean])
jsonb_insert(target jsonb, path text[], new_value jsonb [, insert_after boolean])

Make Sense of Your Database

Part II: Scenarios

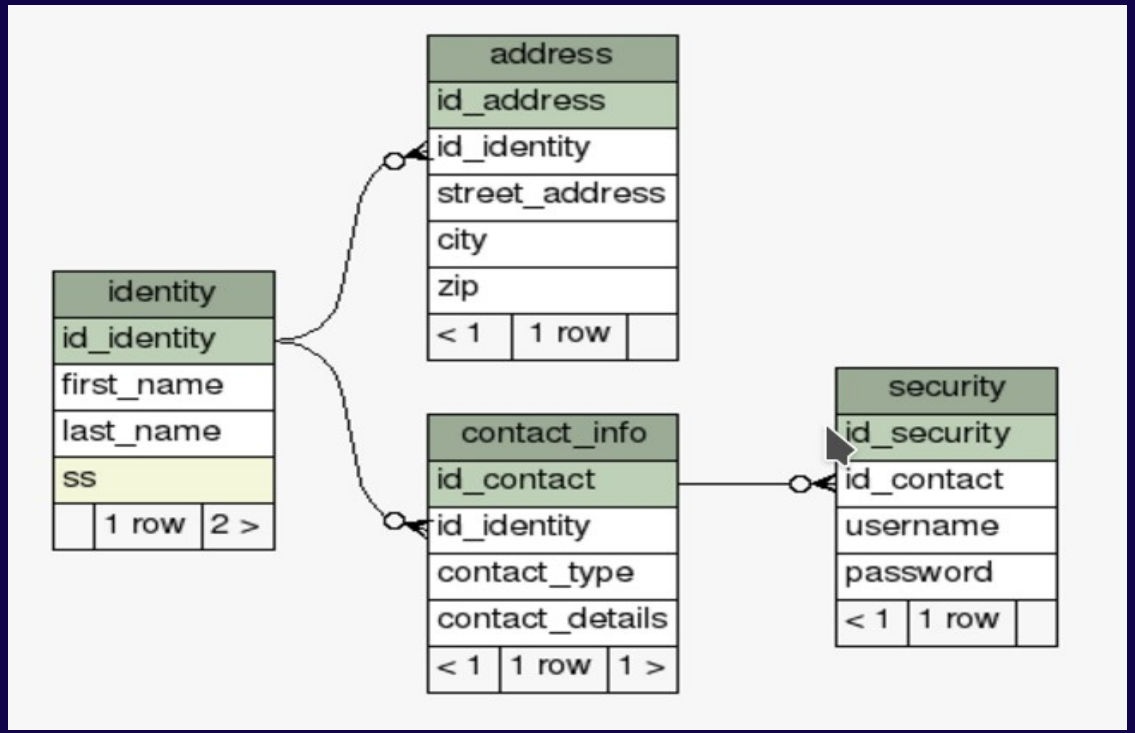
Create Database

- Populate Database
- Translate Relational to JSON
- Queries

Create Database

```
BEGIN;
    create extension pgcrypto;
    create or replace function f_password_hash()
    returns trigger
    as
    $$
    begin
        NEW.password = crypt(NEW.password::text, gen_salt('md5'));
        RETURN NEW;
    end;
    $$
    language plpgsql;

    create type type_communication as enum ('email', 'slack', 'skype');

    create table if not exists identity (
        id_identity integer primary key generated by default as identity,
        first_name varchar(15) not null,
        last_name varchar(60) not null,
        ss char(9) unique not null check (ss ~ '^[[:digit:]]{9}$')
    );

    create table if not exists address (
        id_address integer primary key generated by default as identity,
        id_identity integer references identity(id_identity) not null ,
        street_address varchar(128) null,
        city varchar(64) null,
        zip char(5) null check (zip ~ '^[[:digit:]]{5}$')
    );

    create table if not exists contact_info (
        id_contact integer primary key generated by default as identity,
        id_identity integer references identity(id_identity) not null,
        contact_type type_communication not null,
        contact_details varchar(64) not null
    );

    create table if not exists security (
        id_security integer primary key generated by default as identity,
        id_contact integer references contact_info (id_contact),
        username varchar(16) not null,
        password varchar not null
    );

    create table document (
        id_doc integer primary key generated by default as identity,
        myrecord json
    );


    create trigger tr_password_hash
        before insert or update
        on security
        for each row
        execute function f_password_hash();
COMMIT;
```

Entity Relationship Diagram



Populate Database

```
BEGIN;

insert into identity(first_name,last_name,ss)
   values ('robert','bernier',123456789) returning id_identity;

insert into address (id_identity, street_address, city, zip)
   values (1,'123 my address','my city','12345') returning id_address;

insert into contact_info (id_identity, contact_type, contact_details)
   values (1, 'email','robert.bernier@percona.com'),
          (1, 'skype','rbernier_zulu'),
          (1, 'slack','rbernier') returning id_contact;

insert into security (id_contact, username, password)
   values (1,'user1','mypassword'),
          (2,'user2','mypassword'),
          (3,'user3','mypassword')
   returning id_security, password;
```

```
insert into identity(first_name,last_name,ss)
   values ('conrad','black',234567891) returning id_identity;

insert into address (id_identity, street_address, city, zip)
   values (2,'1313 mocking bird lane','smallville','23451')
   returning id_address;

insert into contact_info (id_identity, contact_type, contact_details)
   values (2, 'email','user1'),
          (2, 'skype','user2') returning id_contact;

COMMIT;
ANALYZE;
```

Translate Relational to JSON row_to_json

```
-------------------------------------------------------------
\df row_to_json
                                 List of functions
   Schema   |    Name     | Result data type | Argument data types | Type
------------+-------------+------------------+---------------------+------
 pg_catalog | row_to_json | json             | record              | func
 pg_catalog | row_to_json | json             | record, boolean     | func
```

Translate Relational to JSON
EX: row_to_json

```
with a (i,j,k,l,m,n,o) as
      (
         select  id_identity,
                 first_name,
                 last_name,
                 ss,
                 street_address,
                 city m,
                 zip n
         from identity
         join address using (id_identity)
      ),
    b as (select row_to_json(row(i,j,k,l,m,n,o)) as r from a)
select * from b;
```

```
                                        r
------------------------------------------------------------------------------------------------------------
 {"f1":1,"f2":"robert","f3":"bernier","f4":"123456789","f5":"123 my address","f6":"my city","f7":"12345"}
 {"f1":2,"f2":"conrad","f3":"black","f4":"234567891","f5":"1313 mocking bird lane","f6":"smallville","f7":"23451"}
```

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Translate Relational to JSON EX cont'd: row_to_json

```
with a (i,j,k) as
      (
         select  id_identity,
                 username,
                 password
         from security
         join contact_info using (id_contact)
         join identity using (id_identity)
      )
select row_to_json(row(i,j,k)) as r from a;
```

```
                                  r
-------------------------------------------------------------------
 {"f1":1,"f2":"user1","f3":"$1$alvLhvAx$iseOfgiKDbvRrWRPz9Jpb/"}
 {"f1":1,"f2":"user2","f3":"$1$VADRCU8H$U5YGB7NNJWM9vdSe9QJah."}
 {"f1":1,"f2":"user3","f3":"$1$ko4Yb/wR$j.6/eEIcuj.4rAEL8rpuo1"}
```

Translate Relational to JSON
EX: Building The Document

```
with
   a as (select  id_identity,
                 username,
                 password
           from security
           join contact_info using (id_contact)
           join identity using (id_identity)),
   b as (select json_agg(json_build_object(username,password)) from a),
   c as (select json_build_object('username_password',json_agg) as charlie from b),
   d as (select json_build_object (
           'id_identity',  id_identity,
           'first_name',   first_name,
           'last_name',    last_name,
           'ss',           ss,
           'street_address',street_address,
           'city',         city,
           'zip',          zip
         ) as delta from identity
          join address using (id_identity))
insert into document(myrecord)
   select delta::jsonb || charlie::jsonb from c,d;
```

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Queries

```
-- QUERY 1:
select myrecord from document;

{"ss": "123456789", "zip": "12345", "city": "my city", "last_name": "bernier", "first_name":
"robert", "id_identity": 1, "street_address": "123 my address", "username_password":
[{"robert.bernier": "$1$LZoB/slh$W.stf.vWGrR7/diNJ/UeU1"}, {"rbernier_zulu": "$1$uGnN/7tV
$FiFEm5POZKIlYnGAjNutg0"}, {"rbernier": "$1$MPRrHGpH$dqeVGlSAl2cT2CS44MTUa0"}, {"conrad.black":
"$1$6uDGVVu9$qIKVZht3EYjdjIIKT1YXO0"}, {"cblack_literary": "$1$dibFFjBx$23/xMXavCVc0IscDPMO0f0"}]}
```

Queries

```
-- QUERY 2:
select myrecord -> 'first_name' as "first name" from document limit 1;

 first name
------------
 "robert"
```

Queries

```
-- QUERY 3:
select myrecord -> 'last_name' as "last name" from document limit 1;

 last name
-----------
 "bernier"
```

Queries

```
-- QUERY 4:
select myrecord -> 'username_password' as "username/passswords" from document limit 1;
-------------------------------------------------------------
[{"robert.bernier": "$1$AKXaaSQM$0029cNu0PHb/7UdoF/CbV1"}, {"rbernier_zulu":
"$1$arVZSMo3$UVCjAVhyhXQmfpnYDkpIY1"}, {"rbernier": "$1$Q7urUIjO$Sm992oUd7Y4dc/QruSV7Z0"}]
```

Queries

```
-- QUERY 5:
select myrecord -> 'username_password' ->> 0  as "username/password" from document  limit 1;

                                username/password
-----------------------------------------------------------------------
 {"robert.bernier": "$1$AKXaaSQM$0029cNu0PHb/7UdoF/CbV1"}
```

Queries

```
-- QUERY 6:
select myrecord -> 'username_password' ->> 1  as "username/password" from document  limit 1;

                    username/password
-------------------------------------------------------------
{"rbernier_zulu": "$1$arVZSMo3$UVCjAVhyhXQmfpnYDkpIY1"}
```

Queries

```
-- QUERY 7:
select myrecord -> 'username_password' ->> 2  as "username/password" from document  limit 1;

                  username/password
-----------------------------------------------------
 {"rbernier": "$1$Q7urUIjO$Sm992oUd7Y4dc/QruSV7Z0"}
```

Queries

```
-- QUERY 8:
select (myrecord -> 'username_password' ->> 0)::json -> 'robert.bernier' as "my password" from
document limit 1;

                my password
-------------------------------------
 "$1$AKXaaSQM$0029cNu0PHb/7UdoF/CbV1"
```

Queries

```
-- QUERY 9:
select myrecord -> 'first_name' as "first name",
       myrecord -> 'last_name' as "last name",
       myrecord -> 'street_address' as "street address",
       myrecord -> 'city' as "city",
       myrecord -> 'zip' as "zip"
from document;


 first name | last name |      street address       |     city     |   zip
------------+-----------+---------------------------+--------------+---------
 "robert"   | "bernier" | "123 my address"          | "my city"    | "12345"
 "conrad"   | "black"   | "1313 mocking bird lane" | "smallville" | "23451"
```

Queries

```
-- QUERY 10:
select myrecord -> 'first_name' as "first name",
       myrecord -> 'last_name' as "last name",
       myrecord -> 'street_address' as "street address",
       myrecord -> 'city' as "city",
       myrecord -> 'zip' as "zip"
from document
where
    myrecord ->> 'first_name' = 'conrad'
and myrecord ->> 'last_name' = 'black';

 first name | last name |      street address      |     city     |   zip
------------+-----------+--------------------------+--------------+---------
 "conrad"   | "black"   | "1313 mocking bird lane" | "smallville" | "23451"
```

Questions?

Thank You!

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Thank you

Message for the end of the presentation goes here

Name goes here

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