PostgreSQL-17 Incremental base backup:

pg_basebackup can take a full or incremental base backup of the database. When used to take a full backup, it makes an exact copy of the database cluster's files. When used to take an incremental backup, some files that would have been part of a full backup may be replaced with incremental versions of the same files, containing only those blocks that have been modified since the reference backup. An incremental backup cannot be used directly; instead, **pg_combinebackup** must first be used to combine it with the previous backups upon which it depends.

Setting Up WAL Archiving and WAL summarizer:

To enable WAL archiving, set the wal_level configuration parameter to replica or higher, archive_mode to on, specify the shell command to use in the archive_command configuration parameter.

Postgres 17 comes with a new background worker process called a WAL summarizer process, which creates “summaries” of WAL files in a directory called pg_wal/summaries. By default, this process is not turned on, but it needs to be for incremental backup to work.

Step1) Edit $PGDATA/postgresql.conf file:

vim $PGDATA/postgresql.conf

wal_level = replica

archive_mode = on

archive_command = 'cp %p /mnt/server/archivedir/%f'

summarize_wal = on

```
[postgres@ip-172-31-20-1 ~]$ vim $PGDATA/postgresql.conf
[postgres@ip-172-31-20-1 ~]$ cat $PGDATA/postgresql.conf |grep -iaE "wal_level|archive_mode|archive_command|summarize_wal"
wal_level = replica                     # minimal, replica, or logical
archive_mode = on               # enables archiving; off, on, or always
                                # (empty string indicates archive_command should
archive_command = 'cp %p /mnt/server/archivedir/%f'             # command to use to archive a WAL file
summarize_wal = on              # run WAL summarizer process?
```

Step2) Create directory for WAL archive logs:

mkdir -p /mnt/server/

chown -R postgres:postgres

```
[root@ip-172-31-20-1 ~]# mkdir -p /mnt/server/archivedir
[root@ip-172-31-20-1 ~]# chown -R postgres:postgres /mnt/server/
```

Step3) Restart the PostgreSQL service and check the status

systemctl restart postgresql-17

systemctl status postgresql-17

```
[root@ip-172-31-20-1 ~]# systemctl restart postgresql-17
[root@ip-172-31-20-1 ~]# systemctl status postgresql-17
● postgresql-17.service - PostgreSQL 17 database server
     Loaded: loaded (/usr/lib/systemd/system/postgresql-17.service; enabled; preset: disabled)
     Active: active (running) since Thu 2024-12-26 09:44:07 UTC; 10s ago
       Docs: https://www.postgresql.org/docs/17/static/
    Process: 2736 ExecStartPre=/usr/pgsql-17/bin/postgresql-17-check-db-dir ${PGDATA} (code=exited, status=0/SUCCESS)
   Main PID: 2742 (postgres)
      Tasks: 9 (limit: 4400)
     Memory: 19.3M
        CPU: 42ms
     CGroup: /system.slice/postgresql-17.service
             ├─2742 /usr/pgsql-17/bin/postgres -D /var/lib/pgsql/17/data/
             ├─2743 "postgres: logger "
             ├─2746 "postgres: checkpointer "
             ├─2747 "postgres: background writer "
             ├─2749 "postgres: walwriter "
             ├─2750 "postgres: walsummarizer "
             ├─2751 "postgres: autovacuum launcher "
             ├─2752 "postgres: archiver "
             └─2753 "postgres: logical replication launcher "

Dec 26 09:44:07 ip-172-31-20-1.ec2.internal systemd[1]: Starting PostgreSQL 17 database server...
Dec 26 09:44:07 ip-172-31-20-1.ec2.internal postgres[2742]: 2024-12-26 09:44:07.576 UTC [2742] LOG:  redirecting log output to logging collector process
Dec 26 09:44:07 ip-172-31-20-1.ec2.internal postgres[2742]: 2024-12-26 09:44:07.576 UTC [2742] HINT:  Future log output will appear in directory "log".
Dec 26 09:44:07 ip-172-31-20-1.ec2.internal systemd[1]: Started PostgreSQL 17 database server.
[root@ip-172-31-20-1 ~]#
```

Incremental base backup:

Step1) Create sample database and load some database

CREATE DATABASE demo_db;

\c demo_db

CREATE TABLE orders (order_id SERIAL NOT NULL PRIMARY KEY,customer_id INT,order_date DATE);

INSERT INTO orders (order_id, customer_id, order_date) VALUES(10248, 90, '2021-07-04'),(10249, 81, '2021-07-05'),(10250, 34, '2021-07-08'),(10251, 84, '2021-07-08'),(10252, 76, '2021-07-09'),(10253, 34, '2021-07-10'),(10254, 14, '2021-07-11');

```
postgres=# CREATE DATABASE demo_db;
CREATE DATABASE
postgres=# \c demo_db
You are now connected to database "demo_db" as user "postgres".
demo_db=# CREATE TABLE orders (order_id SERIAL NOT NULL PRIMARY KEY,customer_id INT,order_date DATE);
CREATE TABLE
demo_db=# INSERT INTO orders (order_id, customer_id, order_date) VALUES(10248, 90, '2021-07-04'),(10249, 81, '2021-07-05'),(10250, 34, '2021-07-08'),(10251,
84, '2021-07-08'),(10252, 76, '2021-07-09'),(10253, 34, '2021-07-10'),(10254, 14, '2021-07-11');
INSERT 0 7
demo_db=# SELECT * FROM orders;
 order_id | customer_id | order_date
----------+-------------+------------
    10248 |          90 | 2021-07-04
    10249 |          81 | 2021-07-05
    10250 |          34 | 2021-07-08
    10251 |          84 | 2021-07-08
    10252 |          76 | 2021-07-09
    10253 |          34 | 2021-07-10
    10254 |          14 | 2021-07-11
(7 rows)

demo_db=#
```

Step2) Create a directory for backups:

mkdir /backup_dir

chown -R postgres:postgres /backup_dir/

```
[root@ip-172-31-20-1 ~]# mkdir /backup_dir
[root@ip-172-31-20-1 ~]# chown -R postgres:postgres /backup_dir/
[root@ip-172-31-20-1 ~]# ls -ltrh /backup_dir/
total 0
[root@ip-172-31-20-1 ~]#
```

Step3) Take a full base backup of database cluster

pg_basebackup -D /backup_dir/demo_db_full_basebkp -P

Options:

-D : Sets the target directory to write the output to. pg_basebackup will create this directory (and any missing parent directories) if it does not exist. If it already exists, it must be empty.

-v : verbose

```
[postgres@ip-172-31-20-1 ~]$ pg_basebackup -D /backup_dir/demo_db_full_basebkp -v
pg_basebackup: initiating base backup, waiting for checkpoint to complete
pg_basebackup: checkpoint completed
pg_basebackup: write-ahead log start point: 0/4000028 on timeline 1
pg_basebackup: starting background WAL receiver
pg_basebackup: created temporary replication slot "pg_basebackup_3579"
pg_basebackup: write-ahead log end point: 0/4000120
pg_basebackup: waiting for background process to finish streaming ...
pg_basebackup: syncing data to disk ...
pg_basebackup: renaming backup_manifest.tmp to backup_manifest
pg_basebackup: base backup completed
[postgres@ip-172-31-20-1 ~]$ ls -ltrh /backup_dir/
total 4.0K
drwx------. 20 postgres postgres 4.0K Dec 26 10:12 demo_db_full_basebkp
[postgres@ip-172-31-20-1 ~]$
```

Step4) Insert some data into the table and take incremental base backup

INSERT INTO orders (order_id, customer_id, order_date) VALUES(10255, 68, '2021-07-12'),(10256, 88, '2021-07-15'),(10257, 35, '2021-07-16'),(10258, 20, '2021-07-17'),(10259, 13, '2021-07-18');

```
[postgres@ip-172-31-20-1 ~]$ psql -d demo_db
psql (17.2)
Type "help" for help.

demo_db=# INSERT INTO orders (order_id, customer_id, order_date) VALUES(10255, 68, '2021-07-12'),(10256, 88, '2021-07-15'),(10257, 35, '2021-07-16'),(10258,
20, '2021-07-17'),(10259, 13, '2021-07-18');
INSERT 0 5
demo_db=# SELECT * FROM orders;
 order_id | customer_id | order_date
----------+-------------+------------
    10248 |          90 | 2021-07-04
    10249 |          81 | 2021-07-05
    10250 |          34 | 2021-07-08
    10251 |          84 | 2021-07-08
    10252 |          76 | 2021-07-09
    10253 |          34 | 2021-07-10
    10254 |          14 | 2021-07-11
    10255 |          68 | 2021-07-12
    10256 |          88 | 2021-07-15
    10257 |          35 | 2021-07-16
    10258 |          20 | 2021-07-17
    10259 |          13 | 2021-07-18
(12 rows)

demo_db=#
```

The **backup_manifest** file contains the details of the backup and serves as input for the next incremental backup.

Option -i / --incremental needs to be used to take an incremental backup. Input to this option is the path of the **backup_manifest** file of the previous full/incremental backup.

```
[postgres@ip-172-31-20-1 ~]$ ls -ltrh /backup_dir/demo_db_full_basebkp/backup_manifest
-rw-------. 1 postgres postgres 178K Dec 26 10:12 /backup_dir/demo_db_full_basebkp/backup_manifest
[postgres@ip-172-31-20-1 ~]$ pg_basebackup -D /backup_dir/demo_db_incrm_bkp1 -i /backup_dir/demo_db_full_basebkp/backup_manifest -v
pg_basebackup: initiating base backup, waiting for checkpoint to complete
pg_basebackup: checkpoint completed
pg_basebackup: write-ahead log start point: 0/6000028 on timeline 1
pg_basebackup: starting background WAL receiver
pg_basebackup: created temporary replication slot "pg_basebackup_3786"
pg_basebackup: write-ahead log end point: 0/6000120
pg_basebackup: waiting for background process to finish streaming ...
pg_basebackup: syncing data to disk ...
pg_basebackup: renaming backup_manifest.tmp to backup_manifest
pg_basebackup: base backup completed
```

```
[postgres@ip-172-31-20-1 ~]$ ls -ltrh /backup_dir/
total 8.0K
drwx------. 20 postgres postgres 4.0K Dec 26 10:12 demo_db_full_basebkp
drwx------. 20 postgres postgres 4.0K Dec 26 10:22 demo_db_incrm_bkp1
[postgres@ip-172-31-20-1 ~]$
[postgres@ip-172-31-20-1 ~]$
[postgres@ip-172-31-20-1 ~]$
```

Step5) Again insert some data into the table and take new incremental backup

INSERT INTO orders (order_id, customer_id, order_date) VALUES(10260, 55, '2021-07-19'),(10261, 61, '2021-07-19'),(10262, 65, '2021-07-22'),(10263, 20, '2021-07-23');

ls -ltrh /backup_dir/demo_db_incrm_bkp1/backup_manifest

pg_basebackup -D /backup_dir/demo_db_incrm_bkp2 -i /backup_dir/demo_db_incrm_bkp1/backup_manifest -v

```
[postgres@ip-172-31-20-1 ~]$ psql -d demo_db
psql (17.2)
Type "help" for help.

demo_db=# INSERT INTO orders (order_id, customer_id, order_date) VALUES(10260, 55, '2021-07-19'),(10261, 61, '2021-07-19'),(10262, 65, '2021-07-22'),(10263,
20, '2021-07-23');
INSERT 0 4
demo_db=# SELECT * FROM orders;
 order_id | customer_id | order_date
----------+-------------+------------
    10248 |          90 | 2021-07-04
    10249 |          81 | 2021-07-05
    10250 |          34 | 2021-07-08
    10251 |          84 | 2021-07-08
    10252 |          76 | 2021-07-09
    10253 |          34 | 2021-07-10
    10254 |          14 | 2021-07-11
    10255 |          68 | 2021-07-12
    10256 |          88 | 2021-07-15
    10257 |          35 | 2021-07-16
    10258 |          20 | 2021-07-17
    10259 |          13 | 2021-07-18
    10260 |          55 | 2021-07-19
    10261 |          61 | 2021-07-19
    10262 |          65 | 2021-07-22
    10263 |          20 | 2021-07-23
(16 rows)

demo_db=#
```

```
[postgres@ip-172-31-20-1 ~]$ ls -ltrh /backup_dir/demo_db_incrm_bkp1/backup_manifest
-rw-------. 1 postgres postgres 186K Dec 26 10:22 /backup_dir/demo_db_incrm_bkp1/backup_manifest
[postgres@ip-172-31-20-1 ~]$
[postgres@ip-172-31-20-1 ~]$ pg_basebackup -D /backup_dir/demo_db_incrm_bkp2 -i /backup_dir/demo_db_incrm_bkp1/backup_manifest -v
pg_basebackup: initiating base backup, waiting for checkpoint to complete
pg_basebackup: checkpoint completed
pg_basebackup: write-ahead log start point: 0/8000060 on timeline 1
pg_basebackup: starting background WAL receiver
pg_basebackup: created temporary replication slot "pg_basebackup_3955"
pg_basebackup: write-ahead log end point: 0/8000158
pg_basebackup: waiting for background process to finish streaming ...
pg_basebackup: syncing data to disk ...
pg_basebackup: renaming backup_manifest.tmp to backup_manifest
pg_basebackup: base backup completed
[postgres@ip-172-31-20-1 ~]$ ls -ltrh /backup_dir/
total 12K
drwx------. 20 postgres postgres 4.0K Dec 26 10:12 demo_db_full_basebkp
drwx------. 20 postgres postgres 4.0K Dec 26 10:22 demo_db_incrm_bkp1
drwx------. 20 postgres postgres 4.0K Dec 26 10:30 demo_db_incrm_bkp2
[postgres@ip-172-31-20-1 ~]$
```

Restoring backups:

It's very important to restore the backup taken without any difficulties. To make the restoration easier, a new CLI tool **pg_combinebackup** is introduced in PostgreSQL 17. It helps to reconstruct the full back up from incremental/dependent backups.

Backups should be provided in the series of order, starting with the full backup, followed by incremental backup 1, incremental backup 2, and so on. The **-o/--output** option specifies the output directory where the backup will be restored.

Step1) Restore the backups

pg_combinebackup /backup_dir/demo_db_full_basebkp /backup_dir/demo_db_incrm_bkp1 /backup_dir/demo_db_incrm_bkp2 -o /var/lib/pgsql/17/data

```
[postgres@ip-172-31-20-1 ~]$ ls -ltrh /backup_dir/
total 12K
drwx------. 20 postgres postgres 4.0K Dec 26 10:12 demo_db_full_basebkp
drwx------. 20 postgres postgres 4.0K Dec 26 10:22 demo_db_incrm_bkp1
drwx------. 20 postgres postgres 4.0K Dec 26 10:30 demo_db_incrm_bkp2
[postgres@ip-172-31-20-1 ~]$
[postgres@ip-172-31-20-1 ~]$ pg_combinebackup /backup_dir/demo_db_full_basebkp /backup_dir/demo_db_incrm_bkp1 /backup_dir/demo_db_incrm_bkp2 -o /var/lib/pgsq
l/17/data --dry-run
[postgres@ip-172-31-20-1 ~]$ pg_combinebackup /backup_dir/demo_db_full_basebkp /backup_dir/demo_db_incrm_bkp1 /backup_dir/demo_db_incrm_bkp2 -o /var/lib/pgsq
l/17/data
[postgres@ip-172-31-20-1 ~]$ ls -ltrh /var/lib/pgsql/17/data
total 244K
drwx------. 4 postgres postgres   77 Dec 26 10:44 pg_wal
-rw-------. 1 postgres postgres  225 Dec 26 10:44 backup_label
drwx------. 2 postgres postgres    6 Dec 26 10:44 pg_twophase
drwx------. 2 postgres postgres    6 Dec 26 10:44 pg_subtrans
drwx------. 2 postgres postgres    6 Dec 26 10:44 pg_snapshots
drwx------. 2 postgres postgres    6 Dec 26 10:44 pg_serial
drwx------. 2 postgres postgres    6 Dec 26 10:44 pg_notify
drwx------. 4 postgres postgres   36 Dec 26 10:44 pg_multixact
drwx------. 2 postgres postgres    6 Dec 26 10:44 pg_dynshmem
drwx------. 2 postgres postgres    6 Dec 26 10:44 pg_commit_ts
drwx------. 2 postgres postgres 4.0K Dec 26 10:44 global
drwx------. 6 postgres postgres   46 Dec 26 10:44 base
drwx------. 2 postgres postgres   18 Dec 26 10:44 pg_xact
-rw-------. 1 postgres postgres    3 Dec 26 10:44 PG_VERSION
drwx------. 2 postgres postgres    6 Dec 26 10:44 pg_tblspc
drwx------. 2 postgres postgres    6 Dec 26 10:44 pg_stat_tmp
drwx------. 2 postgres postgres    6 Dec 26 10:44 pg_stat
drwx------. 2 postgres postgres    6 Dec 26 10:44 pg_replslot
drwx------. 4 postgres postgres   68 Dec 26 10:44 pg_logical
-rw-------. 1 postgres postgres  30K Dec 26 10:44 postgresql.conf
-rw-------. 1 postgres postgres   88 Dec 26 10:44 postgresql.auto.conf
-rw-------. 1 postgres postgres 2.6K Dec 26 10:44 pg_ident.conf
-rw-------. 1 postgres postgres 5.4K Dec 26 10:44 pg_hba.conf
drwx------. 2 postgres postgres   32 Dec 26 10:44 log
-rw-------. 1 postgres postgres   30 Dec 26 10:44 current_logfiles
-rw-------. 1 postgres postgres 178K Dec 26 10:44 backup_manifest
[postgres@ip-172-31-20-1 ~]$
```

Step3) Start the PostgreSQL service and check the data has been restored or not.

systemctl start postgresql-17

systemctl status postgresql-17

su - postgres

psql -d demo_db

SELECT * FROM orders;

```
[root@ip-172-31-20-1 ~]# systemctl start postgresql-17
[root@ip-172-31-20-1 ~]# systemctl status postgresql-17
● postgresql-17.service - PostgreSQL 17 database server
     Loaded: loaded (/usr/lib/systemd/system/postgresql-17.service; enabled; preset: disabled)
     Active: active (running) since Thu 2024-12-26 10:49:03 UTC; 7s ago
       Docs: https://www.postgresql.org/docs/17/static/
    Process: 4365 ExecStartPre=/usr/pgsql-17/bin/postgresql-17-check-db-dir ${PGDATA} (code=exited, status=0/SUCCESS)
   Main PID: 4370 (postgres)
      Tasks: 9 (limit: 4400)
     Memory: 38.8M
        CPU: 52ms
     CGroup: /system.slice/postgresql-17.service
             ├─4370 /usr/pgsql-17/bin/postgres -D /var/lib/pgsql/17/data/
             ├─4371 "postgres: logger "
             ├─4372 "postgres: checkpointer "
             ├─4373 "postgres: background writer "
             ├─4380 "postgres: walwriter "
             ├─4381 "postgres: walsummarizer "
             ├─4382 "postgres: autovacuum launcher "
             ├─4383 "postgres: archiver "
             └─4384 "postgres: logical replication launcher "

Dec 26 10:49:02 ip-172-31-20-1.ec2.internal systemd[1]: Starting PostgreSQL 17 database server...
Dec 26 10:49:02 ip-172-31-20-1.ec2.internal postgres[4370]: 2024-12-26 10:49:02.998 UTC [4370] LOG:  redirecting log output to logging collector process
Dec 26 10:49:02 ip-172-31-20-1.ec2.internal postgres[4370]: 2024-12-26 10:49:02.998 UTC [4370] HINT:  Future log output will appear in directory "log".
Dec 26 10:49:03 ip-172-31-20-1.ec2.internal systemd[1]: Started PostgreSQL 17 database server.
```

```
[root@ip-172-31-20-1 ~]# su - postgres
Last login: Thu Dec 26 10:40:18 UTC 2024 on pts/1
[postgres@ip-172-31-20-1 ~]$ psql -d demo_db
psql (17.2)
Type "help" for help.

demo_db=# SELECT * FROM orders;
 order_id | customer_id | order_date
----------+-------------+------------
    10248 |          90 | 2021-07-04
    10249 |          81 | 2021-07-05
    10250 |          34 | 2021-07-08
    10251 |          84 | 2021-07-08
    10252 |          76 | 2021-07-09
    10253 |          34 | 2021-07-10
    10254 |          14 | 2021-07-11
    10255 |          68 | 2021-07-12
    10256 |          88 | 2021-07-15
    10257 |          35 | 2021-07-16
    10258 |          20 | 2021-07-17
    10259 |          13 | 2021-07-18
    10260 |          55 | 2021-07-19
    10261 |          61 | 2021-07-19
    10262 |          65 | 2021-07-22
    10263 |          20 | 2021-07-23
(16 rows)

demo_db=#
```

Incremental base backup and restore with multiple tablespaces:

Step1) Create new directories for tablespaces

mkdir -p /db_data/tblspc1

mkdir -p /db_data/tblspc2

chown -R postgres /db_data/

```
[root@ip-172-31-20-1 ~]# mkdir -p /db_data/tblspc1
[root@ip-172-31-20-1 ~]# mkdir -p /db_data/tblspc2
[root@ip-172-31-20-1 ~]# chown -R postgres /db_data/
[root@ip-172-31-20-1 ~]# ls -ltrh /db_data/
total 0
drwxr-xr-x. 2 postgres root 6 Dec 26 11:01 tblspc1
drwxr-xr-x. 2 postgres root 6 Dec 26 11:01 tblspc2
[root@ip-172-31-20-1 ~]#
```

Step2) Create tablespaces

CREATE TABLESPACE tblspc1 LOCATION '/db_data/tblspc1';

CREATE TABLESPACE tblspc2 LOCATION '/db_data/tblspc2';

\db+

```
[postgres@ip-172-31-20-1 ~]$ psql -d demo_db
psql (17.2)
Type "help" for help.

demo_db=# CREATE TABLESPACE tblspc1 LOCATION '/db_data/tblspc1';
CREATE TABLESPACE
demo_db=# CREATE TABLESPACE tblspc2 LOCATION '/db_data/tblspc2';
CREATE TABLESPACE
demo_db=# \db+
                                    List of tablespaces
    Name    |  Owner   |     Location     | Access privileges | Options |  Size   | Description
------------+----------+------------------+-------------------+---------+---------+-------------
 pg_default | postgres |                  |                   |         | 29 MB   |
 pg_global  | postgres |                  |                   |         | 565 kB  |
 tblspc1    | postgres | /db_data/tblspc1 |                   |         | 0 bytes |
 tblspc2    | postgres | /db_data/tblspc2 |                   |         | 0 bytes |
(4 rows)

demo_db=#
```

Step3) Create new tables with tablespaces

CREATE TABLE categories (category_id SERIAL NOT NULL PRIMARY KEY,category_name VARCHAR(255),description VARCHAR(255)) TABLESPACE tblspc1;

INSERT INTO categories (category_name, description) VALUES('Beverages', 'Soft drinks, coffees, teas, beers, and ales'),('Condiments', 'Sweet and savory sauces, relishes, spreads, and seasonings'),('Confections', 'Desserts, candies, and sweet breads');

CREATE TABLE customers (customer_id SERIAL NOT NULL PRIMARY KEY,customer_name VARCHAR(255),contact_name VARCHAR(255),address VARCHAR(255),city VARCHAR(255),postal_code VARCHAR(255),country VARCHAR(255)) TABLESPACE tblspc2;

INSERT INTO customers (customer_name, contact_name, address, city, postal_code, country) VALUES('Alfreds Futterkiste', 'Maria Anders', 'Obere Str. 57', 'Berlin', '12209', 'Germany'),('Ana Trujillo Emparedados y helados', 'Ana Trujillo', 'Avda. de la Constitucion 2222', 'Mexico D.F.', '05021', 'Mexico'),('Antonio Moreno Taquera', 'Antonio Moreno', 'Mataderos 2312', 'Mexico D.F.', '05023', 'Mexico');

```
demo_db=# CREATE TABLE categories (category_id SERIAL NOT NULL PRIMARY KEY,category_name VARCHAR(255),description VARCHAR(255)) TABLESPACE tblspc1;
CREATE TABLE
demo_db=# INSERT INTO categories (category_name, description) VALUES('Beverages', 'Soft drinks, coffees, teas, beers, and ales'),('Condiments', 'Sweet and sa
vory sauces, relishes, spreads, and seasonings'),('Confections', 'Desserts, candies, and sweet breads');
INSERT 0 3
demo_db=# CREATE TABLE customers (customer_id SERIAL NOT NULL PRIMARY KEY,customer_name VARCHAR(255),contact_name VARCHAR(255),address VARCHAR(255),city VARC
HAR(255),postal_code VARCHAR(255),country VARCHAR(255)) TABLESPACE tblspc2;
CREATE TABLE
demo_db=# INSERT INTO customers (customer_name, contact_name, address, city, postal_code, country) VALUES('Alfreds Futterkiste', 'Maria Anders', 'Obere Str.
57', 'Berlin', '12209', 'Germany'),('Ana Trujillo Emparedados y helados', 'Ana Trujillo', 'Avda. de la Constitucion 2222', 'Mexico D.F.', '05021', 'Mexico'),
('Antonio Moreno Taquera', 'Antonio Moreno', 'Mataderos 2312', 'Mexico D.F.', '05023', 'Mexico');
INSERT 0 3
demo_db=# \db+
                                    List of tablespaces
    Name    |  Owner   |     Location     | Access privileges | Options |  Size   | Description
------------+----------+------------------+-------------------+---------+---------+-------------
 pg_default | postgres |                  |                   |         | 29 MB   |
 pg_global  | postgres |                  |                   |         | 565 kB  |
 tblspc1    | postgres | /db_data/tblspc1 |                   |         | 16 kB   |
 tblspc2    | postgres | /db_data/tblspc2 |                   |         | 16 kB   |
(4 rows)

demo_db=#
```

Step4) Remove old backups

cd /backup_dir/

rm -rf demo_db_*

```
[postgres@ip-172-31-20-1 ~]$ cd /backup_dir/
[postgres@ip-172-31-20-1 backup_dir]$ rm -rf demo_db_*
[postgres@ip-172-31-20-1 backup_dir]$ ls -ltrh
total 0
```

Step5) Take a full base backup

pg_basebackup -D /backup_dir/demo_db_data_full_bkp -T /db_data/tblspc1=/backup_dir/demo_db_tblspc1_full_bkp -T /db_data/tblspc2=/backup_dir/demo_db_tblspc2_full_bkp -v

Option:

-T olddir=newdir

Relocates the tablespace in directory olddir to newdir during the backup.

```
[postgres@ip-172-31-20-1 ~]$ pg_basebackup -D /backup_dir/demo_db_data_full_bkp -T /db_data/tblspc1=/backup_dir/demo_db_tblspc1_full_bkp -T /db_data/tblspc2=
/backup_dir/demo_db_tblspc2_full_bkp -v
pg_basebackup: initiating base backup, waiting for checkpoint to complete
pg_basebackup: checkpoint completed
pg_basebackup: write-ahead log start point: 0/C000028 on timeline 1
pg_basebackup: starting background WAL receiver
pg_basebackup: created temporary replication slot "pg_basebackup_5313"
pg_basebackup: write-ahead log end point: 0/C000120
pg_basebackup: waiting for background process to finish streaming ...
pg_basebackup: syncing data to disk ...
pg_basebackup: renaming backup_manifest.tmp to backup_manifest
pg_basebackup: base backup completed
[postgres@ip-172-31-20-1 ~]$ ls -ltrh /backup_dir/
total 4.0K
drwx------.  3 postgres postgres   29 Dec 26 11:27 demo_db_tblspc2_full_bkp
drwx------.  3 postgres postgres   29 Dec 26 11:27 demo_db_tblspc1_full_bkp
drwx------. 20 postgres postgres 4.0K Dec 26 11:27 demo_db_data_full_bkp
[postgres@ip-172-31-20-1 ~]$
```

Step6) Insert new records into the tables and take incremental backup:

INSERT INTO categories (category_name, description) VALUES('Dairy Products', 'Cheeses'),('Grains/Cereals', 'Breads, crackers, pasta, and cereal'),('Meat/Poultry', 'Prepared meats');

INSERT INTO customers (customer_name, contact_name, address, city, postal_code, country) VALUES('Around the Horn', 'Thomas Hardy', '120 Hanover Sq.', 'London', 'WA1 1DP', 'UK'),('Berglunds snabbkoep', 'Christina Berglund', 'Berguvsvegen 8', 'Lulea', 'S-958 22', 'Sweden'),('Blauer See Delikatessen', 'Hanna Moos', 'Forsterstr. 57', 'Mannheim', '68306', 'Germany');

```
[postgres@ip-172-31-20-1 demo_db_data_full_bkp]$ psql -d demo_db
psql (17.2)
Type "help" for help.

demo_db=# INSERT INTO categories (category_name, description) VALUES('Dairy Products', 'Cheeses'),('Grains/Cereals', 'Breads, crackers, pasta, and cereal'),(
'Meat/Poultry', 'Prepared meats');
INSERT 0 3
demo_db=# INSERT INTO customers (customer_name, contact_name, address, city, postal_code, country) VALUES('Around the Horn', 'Thomas Hardy', '120 Hanover Sq.
', 'London', 'WA1 1DP', 'UK'),('Berglunds snabbkoep', 'Christina Berglund', 'Berguvsvegen 8', 'Lulea', 'S-958 22', 'Sweden'),('Blauer See Delikatessen', 'Han
na Moos', 'Forsterstr. 57', 'Mannheim', '68306', 'Germany');
INSERT 0 3
demo_db=#
```

Step7) Take an incremental base backup:

pg_basebackup -D /backup_dir/demo_db_data_incrm_bkp -T /db_data/tblspc1=/backup_dir/demo_db_tblspc1_incrm_bkp -T /db_data/tblspc2=/backup_dir/demo_db_tblspc2_incrm_bkp -i /backup_dir/demo_db_data_full_bkp/backup_manifest -v

```
[postgres@ip-172-31-20-1 ~]$ pg_basebackup -D /backup_dir/demo_db_data_incrm_bkp -T /db_data/tblspc1=/backup_dir/demo_db_tblspc1_incrm_bkp -T /db_data/tblspc
2=/backup_dir/demo_db_tblspc2_incrm_bkp -i /backup_dir/demo_db_data_full_bkp/backup_manifest -v
pg_basebackup: initiating base backup, waiting for checkpoint to complete
pg_basebackup: checkpoint completed
pg_basebackup: write-ahead log start point: 0/E000028 on timeline 1
pg_basebackup: starting background WAL receiver
pg_basebackup: created temporary replication slot "pg_basebackup_6282"
pg_basebackup: write-ahead log end point: 0/E000120
pg_basebackup: waiting for background process to finish streaming ...
pg_basebackup: syncing data to disk ...
pg_basebackup: renaming backup_manifest.tmp to backup_manifest
pg_basebackup: base backup completed
[postgres@ip-172-31-20-1 ~]$ ls -ltrh /backup_dir/
total 8.0K
drwx------.  3 postgres postgres   29 Dec 26 11:27 demo_db_tblspc2_full_bkp
drwx------.  3 postgres postgres   29 Dec 26 11:27 demo_db_tblspc1_full_bkp
drwx------. 20 postgres postgres 4.0K Dec 26 11:27 demo_db_data_full_bkp
drwx------.  3 postgres postgres   29 Dec 26 12:12 demo_db_tblspc2_incrm_bkp
drwx------.  3 postgres postgres   29 Dec 26 12:12 demo_db_tblspc1_incrm_bkp
drwx------. 20 postgres postgres 4.0K Dec 26 12:12 demo_db_data_incrm_bkp
[postgres@ip-172-31-20-1 ~]$
```

Step8) Stop PostgreSQL service and remove the current data directory files:

systemctl stop postgresql-17

systemctl status postgresql-17

rm -rf /var/lib/pgsql/17/data/*

ls -ltrh /var/lib/pgsql/17/data/

rm -rf /db_data/tblspc1/*

ls -ltrh /db_data/tblspc1/

rm -rf /db_data/tblspc2/*

ls -ltrh /db_data/tblspc2/

```
[root@ip-172-31-20-1 ~]# systemctl stop postgresql-17
[root@ip-172-31-20-1 ~]# systemctl status postgresql-17
o postgresql-17.service - PostgreSQL 17 database server
     Loaded: loaded (/usr/lib/systemd/system/postgresql-17.service; enabled; preset: disabled)
     Active: inactive (dead) since Thu 2024-12-26 12:38:05 UTC; 6s ago
   Duration: 1h 49min 2.043s
       Docs: https://www.postgresql.org/docs/17/static/
    Process: 4365 ExecStartPre=/usr/pgsql-17/bin/postgresql-17-check-db-dir ${PGDATA} (code=exited, status=0/SUCCESS)
    Process: 4370 ExecStart=/usr/pgsql-17/bin/postgres -D ${PGDATA} (code=exited, status=0/SUCCESS)
   Main PID: 4370 (code=exited, status=0/SUCCESS)
        CPU: 836ms

Dec 26 10:49:02 ip-172-31-20-1.ec2.internal systemd[1]: Starting PostgreSQL 17 database server...
Dec 26 10:49:02 ip-172-31-20-1.ec2.internal postgres[4370]: 2024-12-26 10:49:02.998 UTC [4370] LOG:  redirecting log output to logging collector process
Dec 26 10:49:02 ip-172-31-20-1.ec2.internal postgres[4370]: 2024-12-26 10:49:02.998 UTC [4370] HINT:  Future log output will appear in directory "log".
Dec 26 10:49:03 ip-172-31-20-1.ec2.internal systemd[1]: Started PostgreSQL 17 database server.
Dec 26 12:38:05 ip-172-31-20-1.ec2.internal systemd[1]: Stopping PostgreSQL 17 database server...
Dec 26 12:38:05 ip-172-31-20-1.ec2.internal systemd[1]: postgresql-17.service: Deactivated successfully.
Dec 26 12:38:05 ip-172-31-20-1.ec2.internal systemd[1]: Stopped PostgreSQL 17 database server.
[root@ip-172-31-20-1 ~]# rm -rf /var/lib/pgsql/17/data/*
[root@ip-172-31-20-1 ~]# ls -ltrh /var/lib/pgsql/17/data/
total 0
[root@ip-172-31-20-1 ~]# rm -rf /db_data/tblspc1/*
[root@ip-172-31-20-1 ~]# ls -ltrh /db_data/tblspc1/
total 0
[root@ip-172-31-20-1 ~]# rm -rf /db_data/tblspc2/*
[root@ip-172-31-20-1 ~]# ls -ltrh /db_data/tblspc2/
total 0
[root@ip-172-31-20-1 ~]#
```

Step9) Restore backups

pg_combinebackup -T /backup_dir/demo_db_tblspc1_incrm_bkp=/db_data/tblspc1 -T /backup_dir/demo_db_tblspc2_incrm_bkp=/db_data/tblspc2 /backup_dir/demo_db_data_full_bkp /backup_dir/demo_db_data_incrm_bkp -o /var/lib/pgsql/17/data --dry-run

pg_combinebackup -T /backup_dir/demo_db_tblspc1_incrm_bkp=/db_data/tblspc1 -T /backup_dir/demo_db_tblspc2_incrm_bkp=/db_data/tblspc2 /backup_dir/demo_db_data_full_bkp /backup_dir/demo_db_data_incrm_bkp -o /var/lib/pgsql/17/data

Options:

-T olddir=newdir

Relocates the tablespace in directory olddir to newdir during the backup. olddir is the absolute path of the tablespace as it exists in the final backup specified on the command line, and newdir is the absolute path to use for the tablespace in the reconstructed backup.

--dry-run

The -n/--dry-run option instructs pg_combinebackup to figure out what would be done without actually creating the target directory or any output files. It is particularly useful in combination with --debug.

```
[postgres@ip-172-31-20-1 ~]$ pg_combinebackup -T /backup_dir/demo_db_tblspc1_incrm_bkp=/db_data/tblspc1 -T /backup_dir/demo_db_tblspc2_incrm_bkp=/db_data/tbl
spc2 /backup_dir/demo_db_data_full_bkp /backup_dir/demo_db_data_incrm_bkp -o /var/lib/pgsql/17/data --dry-run
[postgres@ip-172-31-20-1 ~]$ pg_combinebackup -T /backup_dir/demo_db_tblspc1_incrm_bkp=/db_data/tblspc1 -T /backup_dir/demo_db_tblspc2_incrm_bkp=/db_data/tbl
spc2 /backup_dir/demo_db_data_full_bkp /backup_dir/demo_db_data_incrm_bkp -o /var/lib/pgsql/17/data
[postgres@ip-172-31-20-1 ~]$ ls -ltrh /var/lib/pgsql/17/data
total 248K
drwx------. 4 postgres postgres   77 Dec 26 12:41 pg_wal
-rw-------. 1 postgres postgres  225 Dec 26 12:41 backup_label
drwx------. 2 postgres postgres    6 Dec 26 12:41 pg_commit_ts
drwx------. 2 postgres postgres 4.0K Dec 26 12:41 global
drwx------. 2 postgres postgres    6 Dec 26 12:41 pg_twophase
drwx------. 2 postgres postgres    6 Dec 26 12:41 pg_subtrans
drwx------. 2 postgres postgres    6 Dec 26 12:41 pg_snapshots
drwx------. 2 postgres postgres    6 Dec 26 12:41 pg_serial
drwx------. 2 postgres postgres    6 Dec 26 12:41 pg_notify
drwx------. 4 postgres postgres   36 Dec 26 12:41 pg_multixact
drwx------. 2 postgres postgres    6 Dec 26 12:41 pg_dynshmem
drwx------. 6 postgres postgres   46 Dec 26 12:41 base
-rw-------. 1 postgres postgres  30K Dec 26 12:41 postgresql.conf
-rw-------. 1 postgres postgres   88 Dec 26 12:41 postgresql.auto.conf
drwx------. 2 postgres postgres   18 Dec 26 12:41 pg_xact
-rw-------. 1 postgres postgres    3 Dec 26 12:41 PG_VERSION
drwx------. 2 postgres postgres    6 Dec 26 12:41 pg_stat_tmp
drwx------. 2 postgres postgres    6 Dec 26 12:41 pg_stat
drwx------. 2 postgres postgres    6 Dec 26 12:41 pg_replslot
drwx------. 4 postgres postgres   68 Dec 26 12:41 pg_logical
-rw-------. 1 postgres postgres 2.6K Dec 26 12:41 pg_ident.conf
-rw-------. 1 postgres postgres 5.4K Dec 26 12:41 pg_hba.conf
drwx------. 2 postgres postgres   32 Dec 26 12:41 log
-rw-------. 1 postgres postgres   30 Dec 26 12:41 current_logfiles
-rw-------. 1 postgres postgres  225 Dec 26 12:41 backup_label.old
drwx------. 2 postgres postgres   32 Dec 26 12:41 pg_tblspc
-rw-------. 1 postgres postgres 180K Dec 26 12:41 backup_manifest
[postgres@ip-172-31-20-1 ~]$ ls -ltrh /db_data/tblspc1
total 0
drwx------. 3 postgres postgres 19 Dec 26 12:41 PG_17_202406281
[postgres@ip-172-31-20-1 ~]$ ls -ltrh /db_data/tblspc2
total 0
drwx------. 3 postgres postgres 19 Dec 26 12:41 PG_17_202406281
[postgres@ip-172-31-20-1 ~]$
```

Step10) Start the PostgreSQL service and check the data has been restored or not.

```
[root@ip-172-31-20-1 ~]# systemctl start postgresql-17
[root@ip-172-31-20-1 ~]# systemctl status postgresql-17
● postgresql-17.service - PostgreSQL 17 database server
     Loaded: loaded (/usr/lib/systemd/system/postgresql-17.service; enabled; preset: disabled)
     Active: active (running) since Thu 2024-12-26 12:42:58 UTC; 9s ago
       Docs: https://www.postgresql.org/docs/17/static/
    Process: 6908 ExecStartPre=/usr/pgsql-17/bin/postgresql-17-check-db-dir ${PGDATA} (code=exited, status=0/SUCCESS)
   Main PID: 6913 (postgres)
      Tasks: 9 (limit: 4400)
     Memory: 35.3M
        CPU: 59ms
     CGroup: /system.slice/postgresql-17.service
             ├─6913 /usr/pgsql-17/bin/postgres -D /var/lib/pgsql/17/data/
             ├─6914 "postgres: logger "
             ├─6915 "postgres: checkpointer "
             ├─6916 "postgres: background writer "
             ├─6923 "postgres: walwriter "
             ├─6924 "postgres: walsummarizer "
             ├─6925 "postgres: autovacuum launcher "
             ├─6926 "postgres: archiver "
             └─6927 "postgres: logical replication launcher "

Dec 26 12:42:58 ip-172-31-20-1.ec2.internal systemd[1]: Starting PostgreSQL 17 database server...
Dec 26 12:42:58 ip-172-31-20-1.ec2.internal postgres[6913]: 2024-12-26 12:42:58.534 UTC [6913] LOG:  redirecting log output to logging collector process
Dec 26 12:42:58 ip-172-31-20-1.ec2.internal postgres[6913]: 2024-12-26 12:42:58.534 UTC [6913] HINT:  Future log output will appear in directory "log".
Dec 26 12:42:58 ip-172-31-20-1.ec2.internal systemd[1]: Started PostgreSQL 17 database server.
```

```
[root@ip-172-31-20-1 ~]# su - postgres
Last login: Thu Dec 26 12:40:39 UTC 2024 on pts/4
[postgres@ip-172-31-20-1 ~]$ psql -d demo_db
psql (17.2)
Type "help" for help.

demo_db=# \dt+
                                    List of relations
 Schema |    Name    | Type  |  Owner   | Persistence | Access method |    Size    | Description
--------+------------+-------+----------+-------------+---------------+------------+-------------
 public | categories | table | postgres | permanent   | heap          | 16 kB      |
 public | customers  | table | postgres | permanent   | heap          | 16 kB      |
 public | orders     | table | postgres | permanent   | heap          | 8192 bytes |
(3 rows)

demo_db=# select * from categories;
 category_id | category_name  |                   description
-------------+----------------+--------------------------------------------------
           1 | Beverages      | Soft drinks, coffees, teas, beers, and ales
           2 | Condiments     | Sweet and savory sauces, relishes, spreads, and seasonings
           3 | Confections    | Desserts, candies, and sweet breads
           4 | Dairy Products | Cheeses
           5 | Grains/Cereals | Breads, crackers, pasta, and cereal
           6 | Meat/Poultry   | Prepared meats
(6 rows)

demo_db=# select * from customers;
 customer_id |           customer_name            |    contact_name    |            address            |    city     | postal_code | country
-------------+------------------------------------+--------------------+-------------------------------+-------------+-------------+---------
           1 | Alfreds Futterkiste                | Maria Anders       | Obere Str. 57                 | Berlin      | 12209       | Germany
           2 | Ana Trujillo Emparedados y helados | Ana Trujillo       | Avda. de la Constitucion 2222 | Mexico D.F. | 05021       | Mexico
           3 | Antonio Moreno Taquera             | Antonio Moreno     | Mataderos 2312                | Mexico D.F. | 05023       | Mexico
           4 | Around the Horn                    | Thomas Hardy       | 120 Hanover Sq.               | London      | WA1 1DP     | UK
           5 | Berglunds snabbkoep                | Christina Berglund | Berguvsvegen 8                | Lulea       | S-958 22    | Sweden
           6 | Blauer See Delikatessen            | Hanna Moos         | Forsterstr. 57                | Mannheim    | 68306       | Germany
(6 rows)

demo_db=#
```