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GPDB Data Loading

Pivotal® Greenplum Database

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Agenda

- Introduction
- Data Loading Methods
- Data Loading Performance Tips
- Test it out in the lab

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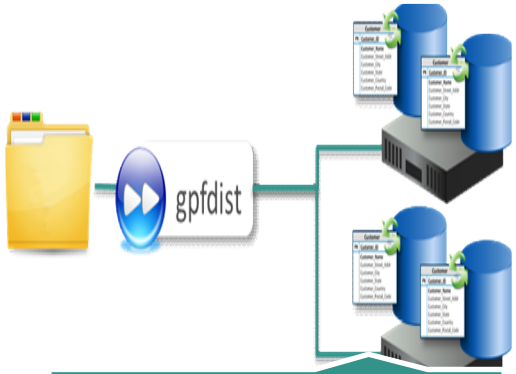
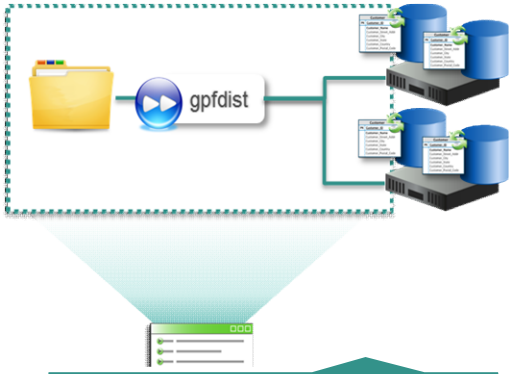
Data Loading Methods

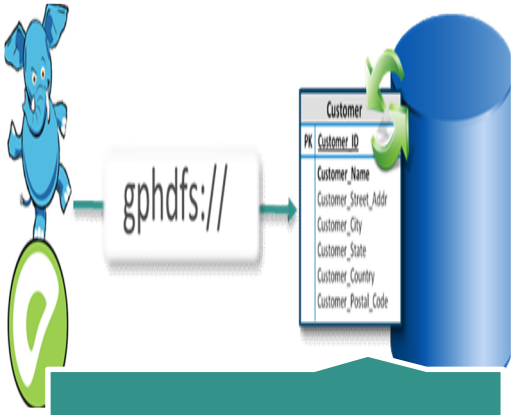
External tables



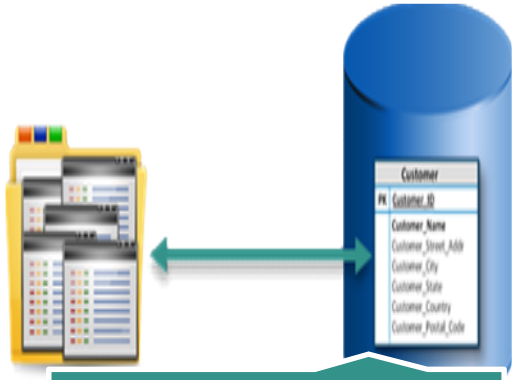
gpfdist



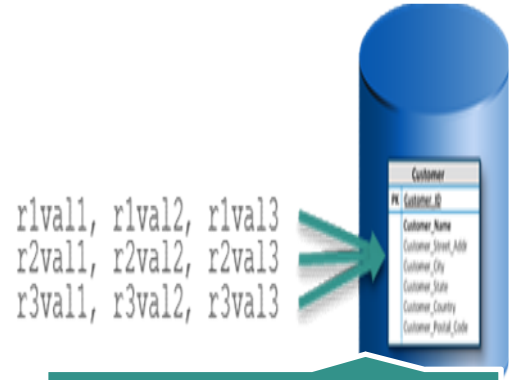
gpload



gphdfs



SQL COPY



SQL INSERT

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Loading with External Tables

Read-only external tables:

- Leverage parallel processing power of segments
- Can be accessed with `SELECT` statements
- Access data outside of the Greenplum Database
- Commonly used for ETL and data loading

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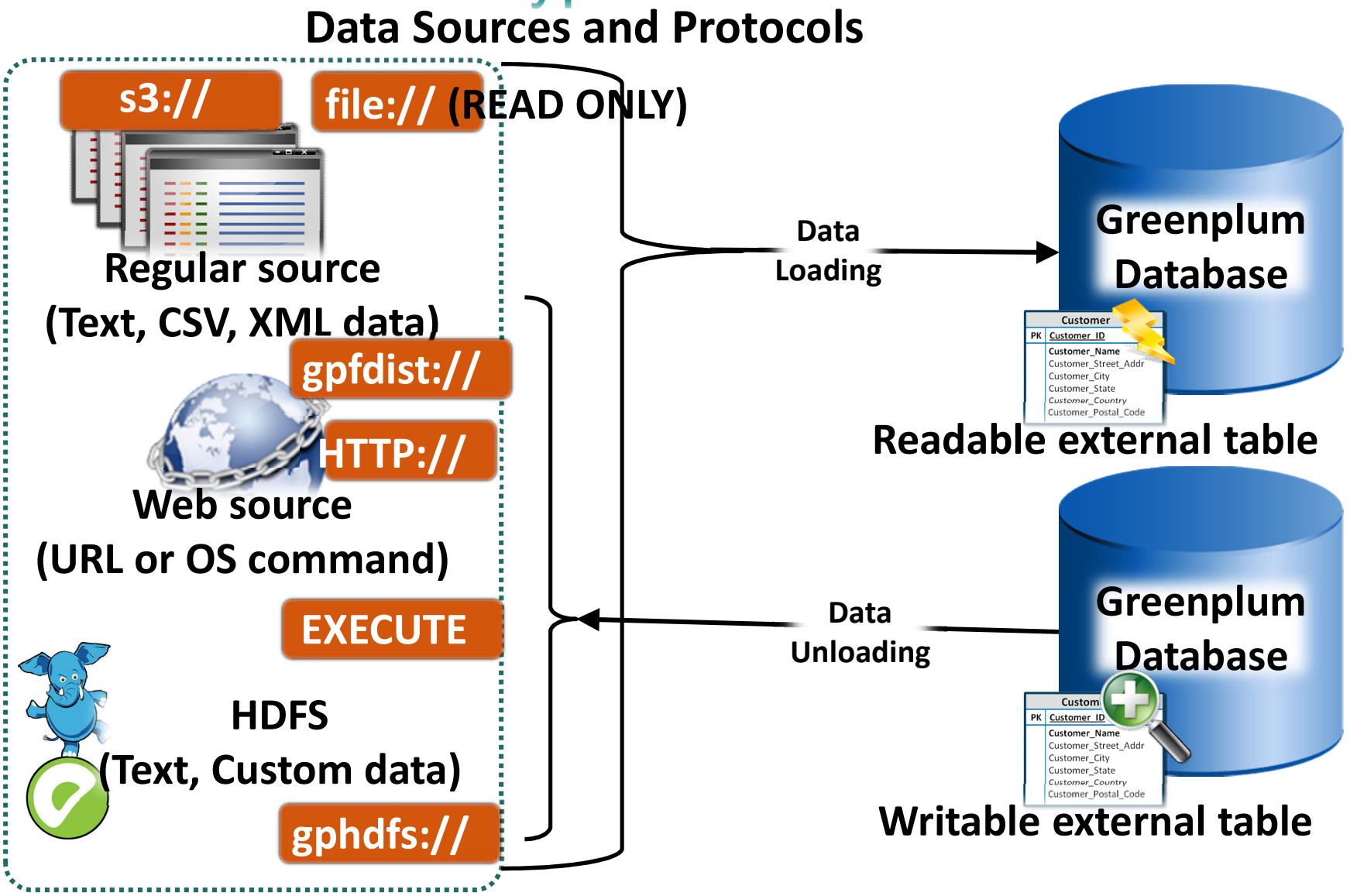
External Table Types



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File-Based External Tables

When creating file-based external tables:

- Specify up to as many URIs as you have segments in the `LOCATION` clause
- Each URI points to an external data file or data source
- URIs do not need to exist prior to defining the external table
- The URI must exist when the data is queried
- Great Blog article: File Protocol for External Tables

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File-Based External Table Protocol and Format

Example: Create an external table with multiple URIs

```
CREATE EXTERNAL TABLE ext_expenses (name text, date date,
amount float4, category text, description text)
LOCATION (
'file://seghost1/dbfast/external/expenses1.csv',
'file://seghost1/dbfast/external/expenses2.csv',
'file://seghost2/dbfast/external/expenses3.csv',
'file://seghost2/dbfast/external/expenses4.csv',
'file://seghost3/dbfast/external/expenses5.csv',
'file://seghost3/dbfast/external/expenses6.csv',
)
FORMAT 'CSV' ( HEADER );
```

Protocol can be `file`, `gpfdist`, `gpfdists`, or `gphdfs`

Format can be `CSV`, `TEXT`, `XML`, or custom

You can define as many URIs as you have segments

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Parallel File Distribution Program

The parallel file distribution program, `gpfdist`:

- Is a C program that uses HTTP
- Can be run on an external server
- Distributes data at 200 MB/s per `gpfdist`
- Provides full parallelism for best performance

The data load utility, `gpload`:

- Interfaces with and invokes `gpfdist`
- Creates an external table definition
- Executes `INSERT`, `UPDATE`, or `MERGE` to load data

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gpfdist Based External Tables

When creating file-based external tables:

- Every segment opens a connection to the remote gpfdist agent (try running it with –V)
- Every segment asks for a block of data (ie. just a bunch of data only parsed for EOL)
  - Max block length must be between 32K and 256MB
- After the data arrives at the segment, then the DSITRIBUTED BY clause is invoked which likely will cause data movement to another segment

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Parallel File Distribution Program Example

```
gpfdist -d /var/load_files/expenses1 -p 8081 >> gpfdist.log
2>&1 &
gpfdist -d /var/load_files/expenses2 -p 8082 >> gpfdist.log
2>&1 &
```

Example: Creating an external table using the `gpfdist` protocol

```
CREATE EXTERNAL TABLE ext_expenses
    (name text, date date,  amount float4, description text)
    LOCATION (
         'gpfdist://etlhost:8081/*',
         'gpfdist://etlhost:8082/*')
    FORMAT 'TEXT' (DELIMITER '|')
    ENCODING 'UTF-8'
    LOG ERRORS INTO ext_expenses_loaderrors
    SEGMENT REJECT LIMIT 10000 ROWS ;
```

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Parallel File Distribution Program Example (Cont'd.)

Example: Load data into a regular table

```
INSERT INTO expenses (SELECT * FROM ext_expenses);
```

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Accessing Hadoop Data Using gphdfs

```
 2 DROP EXTERNAL TABLE IF EXISTS wiki_pages_ext;
 3 CREATE EXTERNAL TABLE wiki_pages_ext
 4 (
 5   LIKE wiki_pages
 6 )
 7 LOCATION ('gphdfs://hadoop-w-0:8020/user/gpadmin/word_count/out/part-m-*')
 8 FORMAT 'TEXT' (DELIMITER  E'\t' NULL E'')
 9 ENCODING 'UTF8'
10 LOG ERRORS INTO wiki_err SEGMENT REJECT LIMIT 1 PERCENT;
11 GRANT SELECT ON wiki_pages_ext TO demo;
12 /*
13 demo=# INSERT INTO wiki_pages
14 demo-# SELECT * FROM wiki_pages_ext;
15 NOTICE:  Found 66 data formatting errors (66 or more input rows). Rejected
16 INSERT 0 15347677
17 Time: 9674.557 ms
18 demo=# select count(*) from wiki_pages;
19   count
20 ----------
21 15347677
22 (1 row)
23 */
```

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Accessing Hadoop Data Using gphdfs (Cont'd.)

One time setup for using gphdfs requires setting a couple of configuration parameters:

`gp_hadoop_target_version` -- corresponds with the version of Hadoop you're using

`gp_hadoop_home` -- points to your Hadoop client installation directory

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gpload YAML Control File Example

Example: YAML Control File for Loading Data

```
VERSION: 1.0.0.1
DATABASE: faa2
USER: gpadmin
HOST: smdw
PORT: 5432
GPLOAD:
  INPUT:
    - SOURCE:
        LOCAL_HOSTNAME:
            - mdw
        PORT: 8081
        FILE:
            - /rawdata/FAAData/On_Time_On_Time_Performance_*.csv
    - FORMAT: csv
    - DELIMITER: ','
    - ESCAPE: '"'
    - QUOTE: '"'
    - HEADER: true
    - ERROR_LIMIT: 100
    - ERROR_TABLE: faadata.faadataerr
  OUTPUT:
    - TABLE: faadata.factontimeperformance
    - MODE: insert
  PRELOAD:
    - TRUNCATE: true
    - REUSE_TABLES: false
  SQL:
    - BEFORE: "INSERT INTO audit VALUES('start', current_timestamp)"
    - AFTER: "INSERT INTO audit VALUES('end', current_timestamp)"
```

Greenplum Database connection information

gpload definition block

Indentation spaces, **not tabs**, determine hierarchy

gpfdist configuration information

Pre-existing table and data entry mode

Preloading data section

Pre and post SQL statements

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gpload Syntax

The gpload syntax is as follows:

```
gpload -f control_file [-l log_file] [-h
hostname] [-p port] [-U username] [-d
database] [-W] [-v | -V] [-q] [-D] gpload
-? | --version
```

The following is an example of how it is used:

Example: Successful data load with gpload

```
$ gpload -f load_faadata.yaml
2012-01-17 09:05:29|INFO|gpload session started 2012-01-17 09:05:29
2012-01-17 09:05:29|INFO|started gpfdist -p 8081 -P 8082 -f
"/rawdata/FAADOn_Time_Performance_*.csv" -t 30
2012-01-17 09:11:23|INFO|running time: 353.36 seconds
2012-01-17 09:11:23|INFO|rows Inserted          = 20860045
2012-01-17 09:11:23|INFO|rows Updated           = 0
2012-01-17 09:11:23|INFO|data formatting errors = 0
2012-01-17 09:11:23|INFO|gpload succeeded
$
```

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Loading Data with `gpload`

Example: Load data with `gpload`

```
$ gpload -f load_faadata.yaml
```

```
gpadmin@mdw:~/course_samples
[gpadmin@mdw course_samples]$ gpload -f load_faadata.yaml
2012-01-19 06:10:57|INFO|gpload session started 2012-01-19 06:10:57
2012-01-19 06:10:57|INFO|started gpfdist -p 8081 -P 8085 -f "/rawdata/FAAData/On
_Time_On_Time_Performance_*.csv" -t 30
```

`gpload` starts `gpfdist`

Query Text

```
INSERT INTO "faadata"."factontimeperformance"
("year","quarterid","monthid","dayofmonth","dayid","flightd
eabbreviation","originstatefipscode","originstatename","orig
stwacid","crsdeptime","deptime","depdelay","depdelay2","d
","arrdelay","arrdelay2","arrdel15","arrdelaygroupid","arrtim
","distance","distancegroupid","carrierdelay","weatherdelay"
tlandings","divertedreacheddest","divactualelapsedtime","di
div1tailnum","div2airport","div2wheelson","div2totalgtime","
id","tailnum","flightnum","originairportid","origincityname","originstat
e","deststateabbreviation","deststatefipscode","deststatename","de
eblkid","taxiout","wheelsoff","wheelson","taxiin","crsarrtime","arrtime
diverted","crselapsedtime","actualelapsedtime","airtime","numflights
aftdelay","firstdeptime","totaladdgtime","longestaddgtime","divairpor
","div1wheelson","div1totalgtime","divlongestgtime","div1wheelsoff","
iv2tailnum","div3airport","div3wheelson","div3totalgtime","div3longe
tgtime","div4wheelsoff","div4tailnum","div5airport","div5wheelson","
div5totalgtime","div5longestgtime","div5wheelsoff","div5tailnum") SELECT
"year","quarterid","monthid","dayofmonth","dayid","flightdate","uniqcarrierid","airlineid","carrierid","tailnum","flightnum","originairportid","origincityname","originstat
eabbreviation","originstatefipscode","originstatename","originwacid","destairportid","destcityname","deststateabbreviation","deststatefipscode","deststatename","de
stwacid","crsdeptime","deptime","depdelay","depdelay2","depdel15","depdelaygroupid","deptimeblkid","taxiout","wheelsoff","wheelson","taxiin","crsarrtime","arrtime
","arrdelay","arrdelay2","arrdel15","arrdelaygroupid","arrtimeblkid","cancelled","cancellationid","diverted","crselapsedtime","actualelapsedtime","airtime","numflights
","distance","distancegroupid","carrierdelay","weatherdelay","nasdelay","securitydelay","lateaircraftdelay","firstdeptime","totaladdgtime","longestaddgtime","divairpor
tlandings","divertedreacheddest","divactualelapsedtime","divarrdelay","divdistance","div1airport","div1wheelson","div1totalgtime","divlongestgtime","div1wheelsoff","
div1tailnum","div2airport","div2wheelson","div2totalgtime","div2longestgtime","div2wheelsoff","div2tailnum","div3airport","div3wheelson","div3totalgtime","div3longe
stgtime","div3wheelsoff","div3tailnum","div4airport","div4wheelson","div4totalgtime","div4longestgtime","div4wheelsoff","div4tailnum","div5airport","div5wheelson","
div5totalgtime","div5longestgtime","div5wheelsoff","div5tailnum"  FROM ext_gpload20120119_060258_15300
0 appname
```

Data is loaded into target table

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External Web Table Protocols and Format

Example: External WEB table with data loads from URLs

```
CREATE EXTERNAL WEB TABLE ext_expenses (name text, date
date, amount float4, description text)
       LOCATION (
'http://intranet.company.com/expenses/sales/expenses.csv',
'http://intranet.company.com/expenses/finance/expenses.csv',
'http://intranet.company.com/expenses/ops/expenses.csv')
FORMAT 'CSV' ( HEADER );
```

Example: External WEB table with data loads from a script

```
CREATE EXTERNAL WEB TABLE log_output (linenum int, message
text)
EXECUTE '/var/load_scripts/get_log_data.sh'
ON HOST FORMAT 'TEXT' (DELIMITER '|');
```

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External Web Table Protocols and Format (Cont'd.)

Example: External WEB table with data loads from a command

```
CREATE EXTERNAL WEB TABLE du_space (storage text)
EXECUTE 'df -k' ON HOST FORMAT 'TEXT';
```

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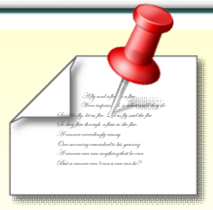
Environment Variables for Command-Based Web Tables

- Are not sourced at the segment host
- Can be set in the `EXECUTE` clause as follows:

Example: External WEB table with environment variables

```
CREATE EXTERNAL WEB TABLE TEST(segname text, abbrev text)
  EXECUTE 'export HNAME="$HOSTNAME"-SR; echo
  "$HOSTNAME,$HNAME"' FORMAT 'TEXT' (DELIMITER ',');
SELECT * FROM test;
segname | abbrev
---------+---------
 sdw2    | sdw2-SR
 sdw1    | sdw1-SR
(2 rows)
```



Note: You can disable the use of the `EXECUTE` command in web table definitions by setting `gp_external_enable_exec` to `off`.

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External Table Environment Variables

Variable	Description
`$GP_CID`	Command count of the session executing the external table statement.
`$GP_DATABASE`	The database that the external table definition resides in.
`$GP_DATE`	The date the external table command was executed.
`$GP_MASTER_HOST`	The host name of the Greenplum master host from which the external table statement was dispatched.
`$GP_MASTER_PORT`	The port number of the Greenplum master instance from which the external table statement was dispatched.
`$GP_SEG_DATADIR`	The location of the data directory of the segment instance executing the external table command.
`$GP_SEG_PG_CONF`	The location of the `postgresql.conf` file of the segment instance executing the external command.

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External Table Environment Variables (cont'd.)

Variable	Description
`$GP_SEG_PORT`	The port number of the segment instance executing the external table command.
`$GP_SEGMENT_COUNT`	The total number of primary segment instances in the Greenplum Database system.
`$GP_SEGMENT_ID`	The ID number of the segment instance executing the external table command.
`$GP_SESSION_ID`	The database session identifier number associated with the external table statement.
`$GP_SN`	Serial number of the external table scan node in the query plan of the external table statement.
`$GP_TIME`	The time the external table command was executed.
`$GP_USER`	The database user executing the external table statement.
`$GP_XID`	The transaction ID of the external table statement.

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External Table Error Handling

When handling errors using external tables:

- Incorrectly formatted rows are rejected:
  - Rows with missing or extra attributes
  - Rows with columns of the wrong data type
  - Rows with invalid client encoding sequence
- CONSTRAINT errors (NOT NULL, CHECK, UNIQUE) are handled “all or nothing” -- not single row isolation
- Format of error handling clause:

```
[LOG ERRORS INTO error_table] SEGMENT
REJECT LIMIT count [ROWS | PERCENT]
```

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External Tables and Planner Statistics

Query planning of complex queries on external tables is not optimal because:

- Data resides outside the database
- No database statistics exist for external table data
- Data from external tables are not meant for frequent or ad-hoc access

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COPY SQL Command

The COPY SQL command:

- Is a PostgreSQL command
- Loads all rows in one command and is not parallel
- Loads data from a file or from standard input
- Supports error handling similar to external tables

The following is an example of the command:

Example: Copy data from `/data/myfile.csv` into the table specified

```
COPY mytable FROM '/data/myfile.csv' WITH CSV HEADER;
```

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Data Loading Performance Tips

- Drop indexes and recreate them after loading data
- Use gpfdist to load or unload data in Greenplum Database
- Spread the data evenly across as many ETL nodes as possible
- Split very large data files into equal parts and spread the data across as many file systems as possible
- Run two gpfdist instances per file system
- Run gpfdist on as many network interfaces as possible

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Data Loading Performance Tips (Cont'd.)

- Use gp_external_max_segs to control the number of segments each gpfdist serves
- Always keep gp_external_max_segs and the number of gpfdist processes an even factor
- Always drop indexes before loading into existing tables and re-create the index after loading
- Always run ANALYZE on the table after loading it
- Disable automatic statistics collection during loading by setting gp_autostats_mode to NONE
- Run VACUUM after load errors to recover space

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Review

- Data Loading Methods
- Data Loading Performance Tips
- Test it out in the lab

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