

Rapid Upgrades With Pg_Upgrade

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Pg_Upgrade allows migration between major releases of Postgres without a data dump/reload. This presentation explains how pg_upgrade works.

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Traditional Postgres Major Upgrade Options

- Minor upgrades are simple
- pg_dump (logical dump)/restore
- Slony

Why Major Upgrades of Postgres Are Complex

- New features often require system table changes
- However, the internal data format rarely changes

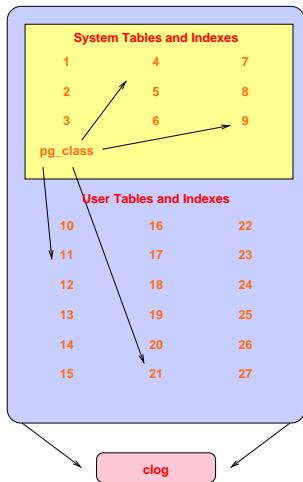
Why Pg_Upgrade

- Very fast upgrades
- Optionally no additional disk space

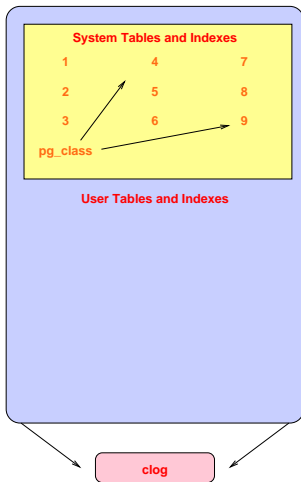
pg_upgrade installs new system tables while using data files from the previous Postgres version.

How It Works: Initial Setup

Old Cluster

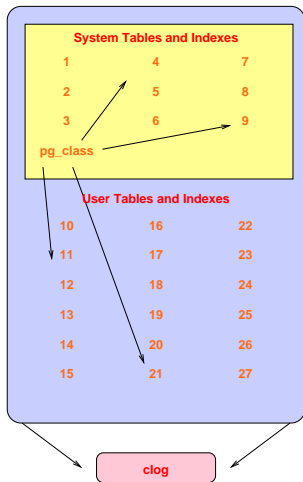


New Cluster

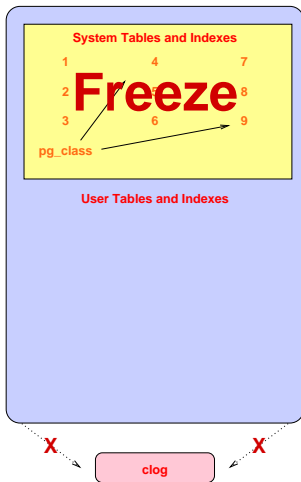


Decouple New Clog Via Freezing

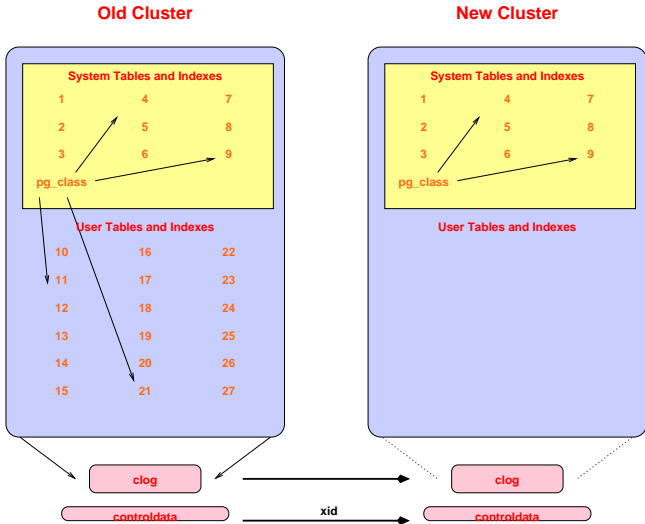
Old Cluster



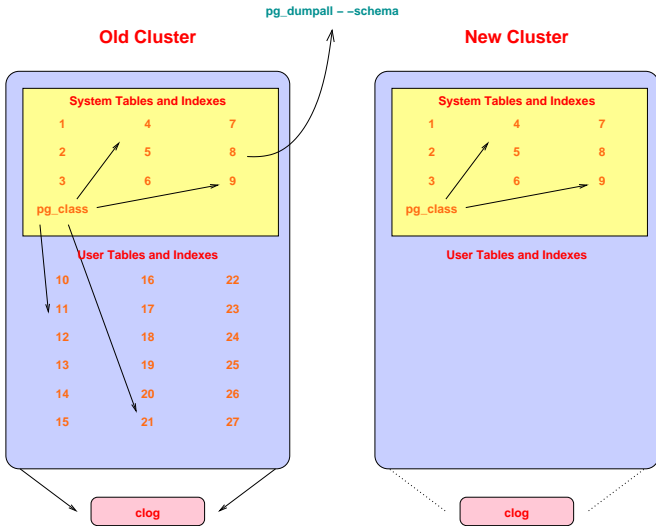
New Cluster



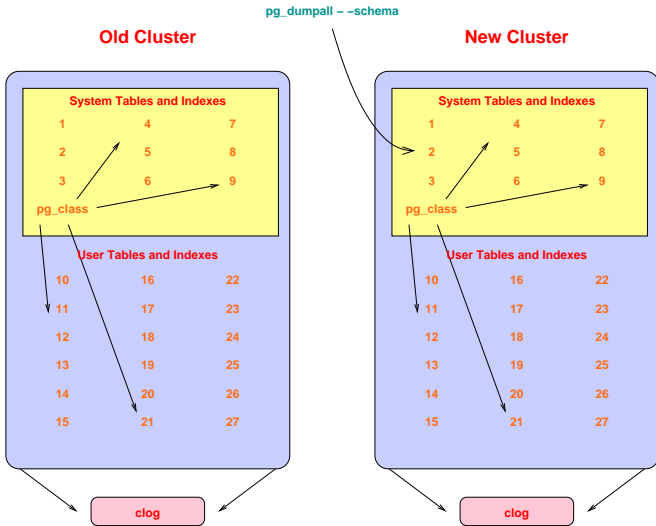
Transfer Clog and XID



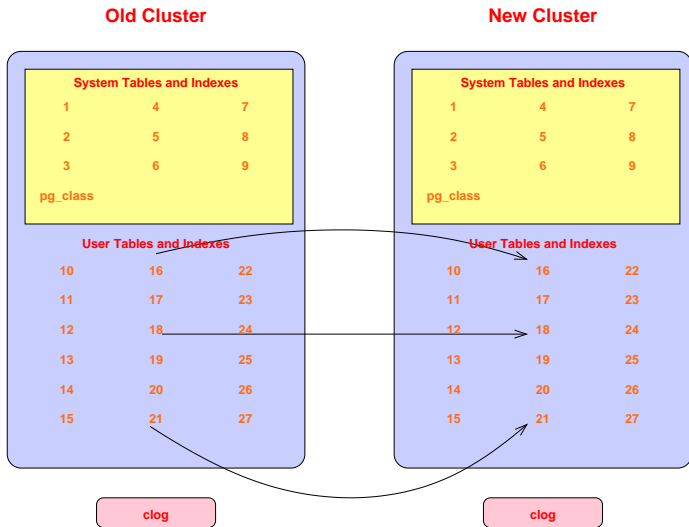
Get Schema Dump



Restore Schema In New Cluster

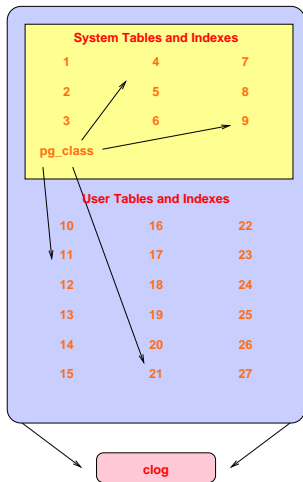


Copy User Heap/Index Files

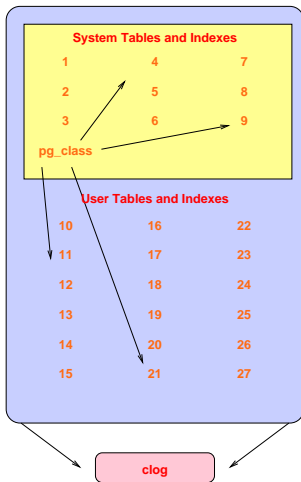


Complete

Old Cluster



New Cluster



How It Works: In Detail

- Check for cluster compatibility
 - locale
 - encoding
- Use `pg_dumpall` to dump old cluster schema (no data)
- Freeze all new cluster rows (remove reference to clog entries)
- New cluster uses old xid counter value (see freeze above)
 - Set system table frozen xids to match the current xid
- Create new users/databases
- Collect cluster information
- Install support functions that call internal backend functions
- Create schema in new cluster
- Copy or link files from old cluster to new cluster
- Warn about any remaining issues, like REINDEX requirements

Sample Run: Performing Consistency Checks

Performing Consistency Checks

```
-----  
Checking current, bin, and data directories           ok  
Checking cluster versions                             ok  
Checking database user is a superuser                ok  
Checking for prepared transactions                   ok  
Checking for reg* system OID user data types         ok  
Checking for invalid indexes from concurrent index builds ok  
Checking for contrib/isn with bigint-passing mismatch ok  
Creating catalog dump                                ok  
Checking for presence of required libraries           ok  
Checking database user is a superuser                ok  
Checking for prepared transactions                   ok
```

If `pg_upgrade` fails after this point, you must re-initdb the new cluster before continuing.

Sample Run: Performing Migration

Performing Upgrade

Analyzing all rows in the new cluster	ok
Freezing all rows on the new cluster	ok
Deleting files from new pg_xact	ok
Copying old pg_xact to new server	ok
Setting next transaction ID for new cluster	ok
Resetting WAL archives	ok
Setting frozenxid counters in new cluster	ok
Creating databases in the new cluster	ok
Adding support functions to new cluster	ok
Restoring database schema to new cluster	ok
Removing support functions from new cluster	ok
Adding ".old" suffix to old global/pg_control	ok

If you want to start the old cluster, you will need to remove the ".old" suffix from /u/pgsql.old/data/global/pg_control.old. Because "link" mode was used, the old cluster cannot be safely started once the new cluster has been started.

Sample Run: Completion

Linking user relation files

ok

Setting next OID for new cluster

ok

Creating script to analyze new cluster

ok

Creating script to delete old cluster

ok

Upgrade Complete

Optimizer statistics are not transferred by pg_upgrade so,
once you start the new server, consider running:

analyze_new_cluster.sh

Running this script will delete the old cluster's data files:

delete_old_cluster.sh

Possible Data Format Changes

Change	Conversion Method
clog	none
heap page header, including bitmask	convert to new page format on read
tuple header, including bitmask	convert to new page format on read
data value format	create old data type in new cluster
index page format	reindex, or recreate index methods
TOAST page format	convert to new page format on read

Speed Comparison

Migration Method	Minutes
dump/restore	300.0
dump with parallel restore	180.0
pg_upgrade in copy mode	44.0
pg_upgrade in link mode	0.7

Database size: 150GB, 850 tables

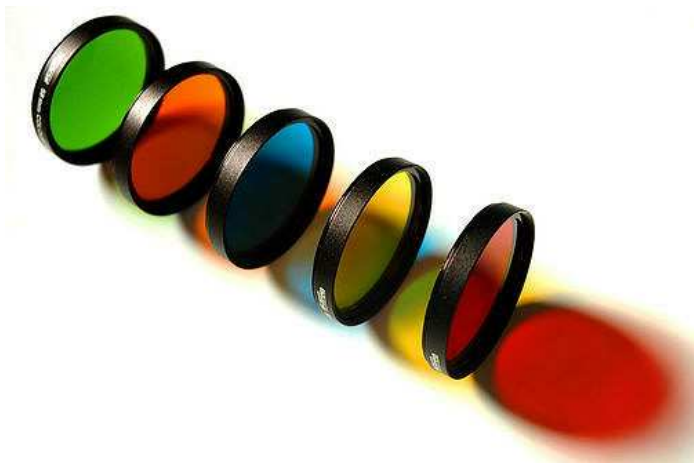
The last duration is 44 *seconds*.

*Timings courtesy of
Stefan Kaltenbrunner
(mastermind on IRC)*

Release History

- 9.0 focused on stability
- 9.1 focused on performance for databases with many relations
- 9.2 focused on improved debugging and reliability for non-standard configurations
- 9.3 focused on performance via parallelism and reduced fsync activity
- 9.4 dramatically reduced memory usage

Conclusion



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