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.

 http://momjian.us/presentations

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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

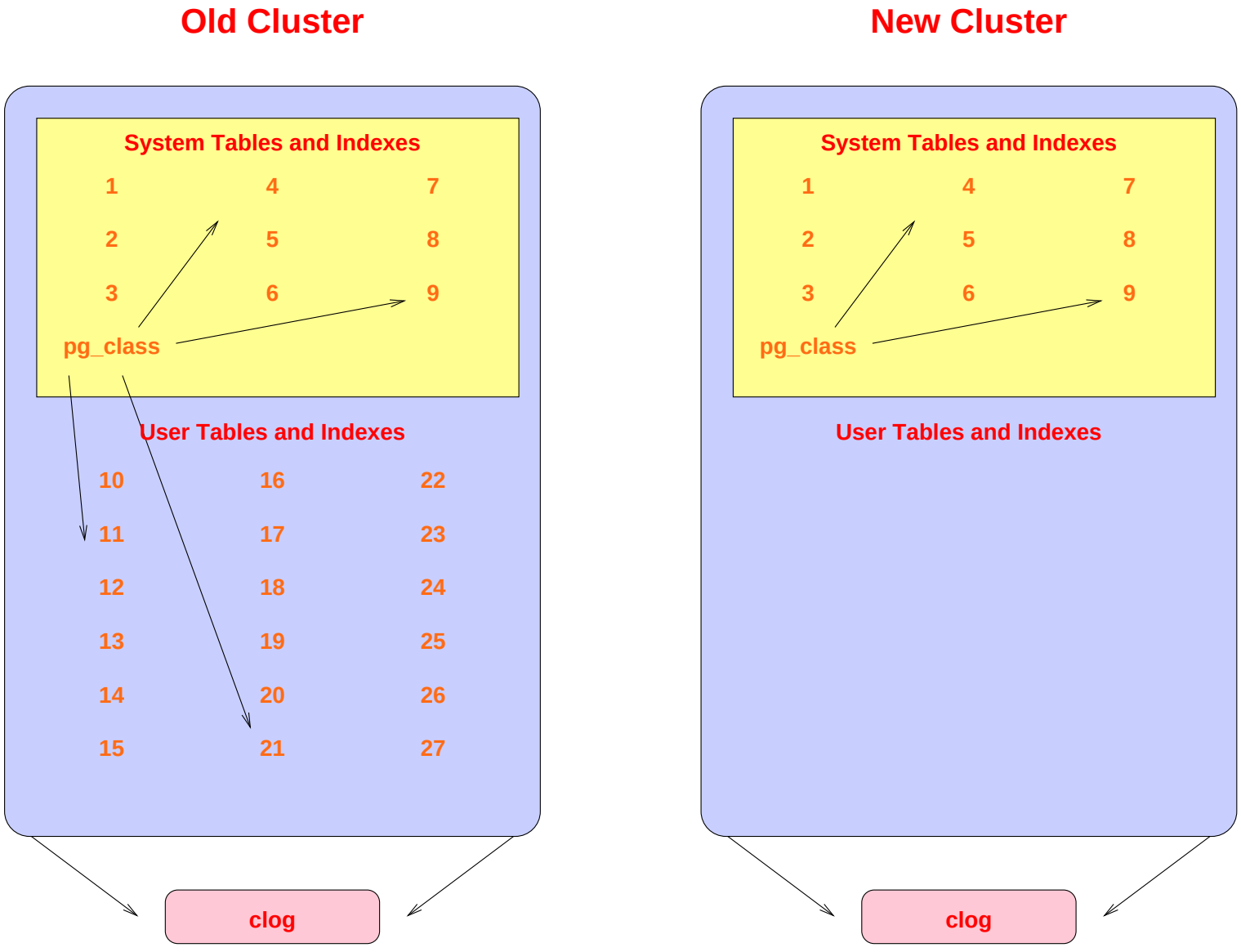
- New features often require system table changes
- However, the internal data format rarely changes

Why Pg_Upgrade

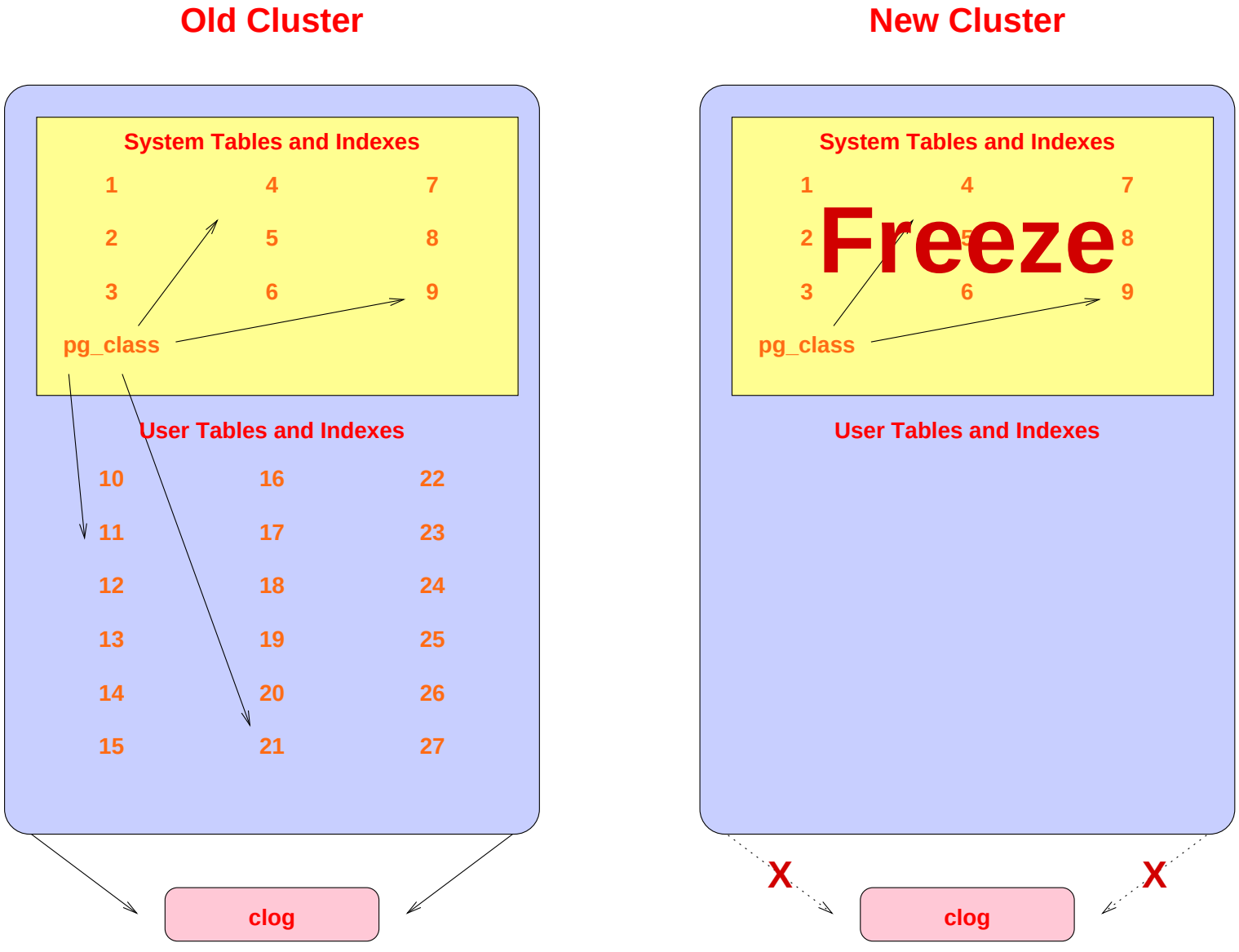
- Very fast upgrades
- Optionally no additional disk space

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

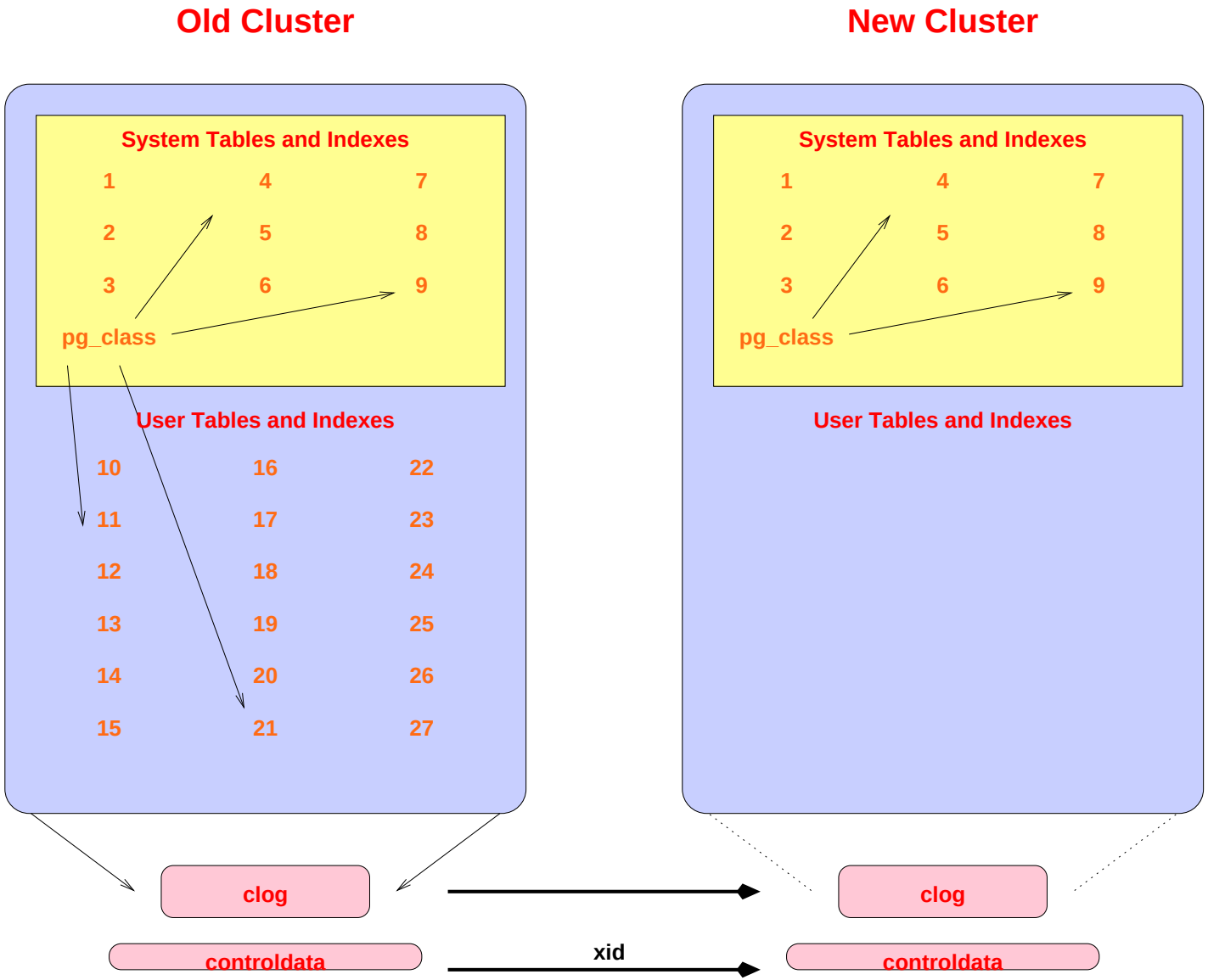
How It Works: Initial Setup



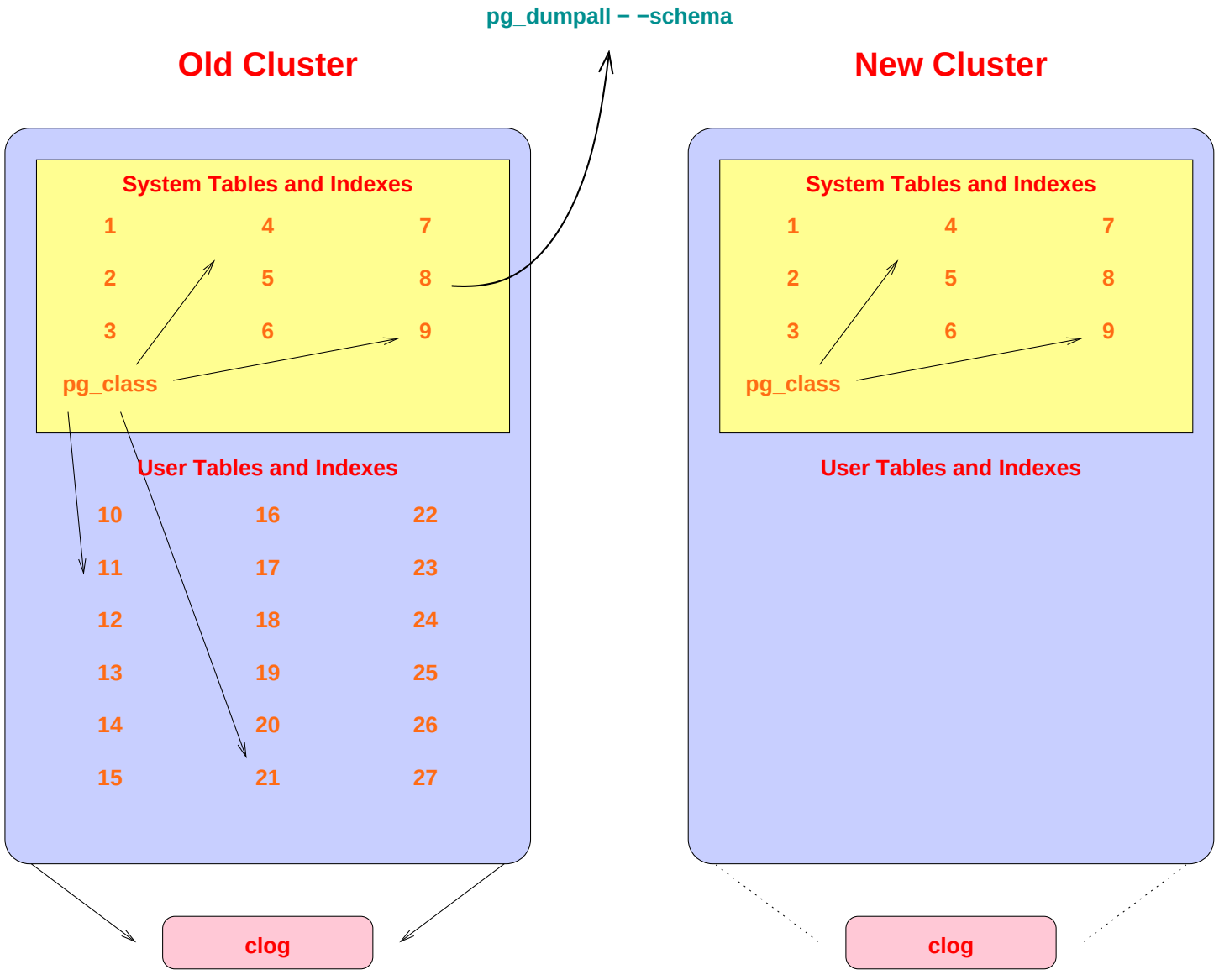
Decouple New Clog Via Freezing



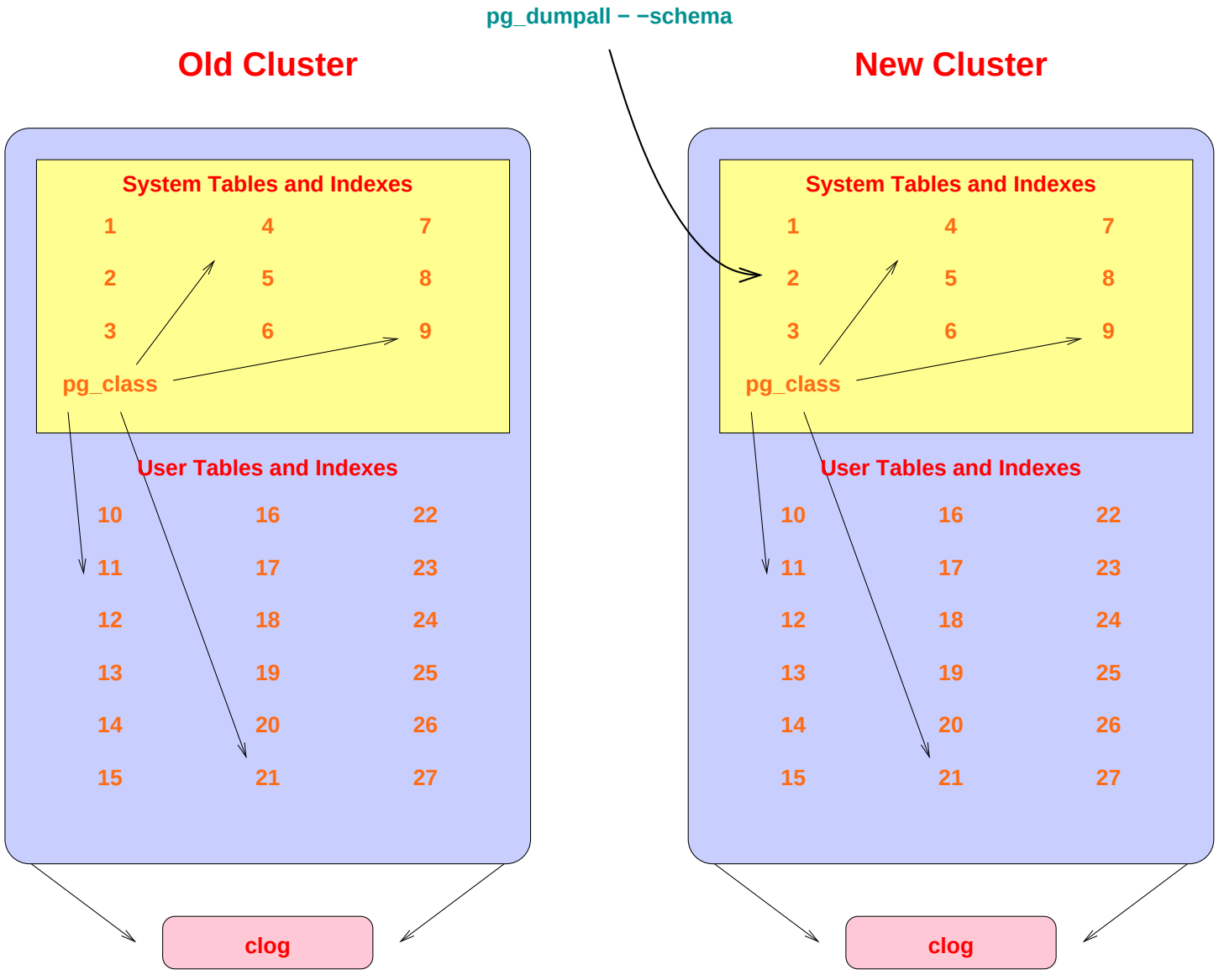
Transfer Clog and XID



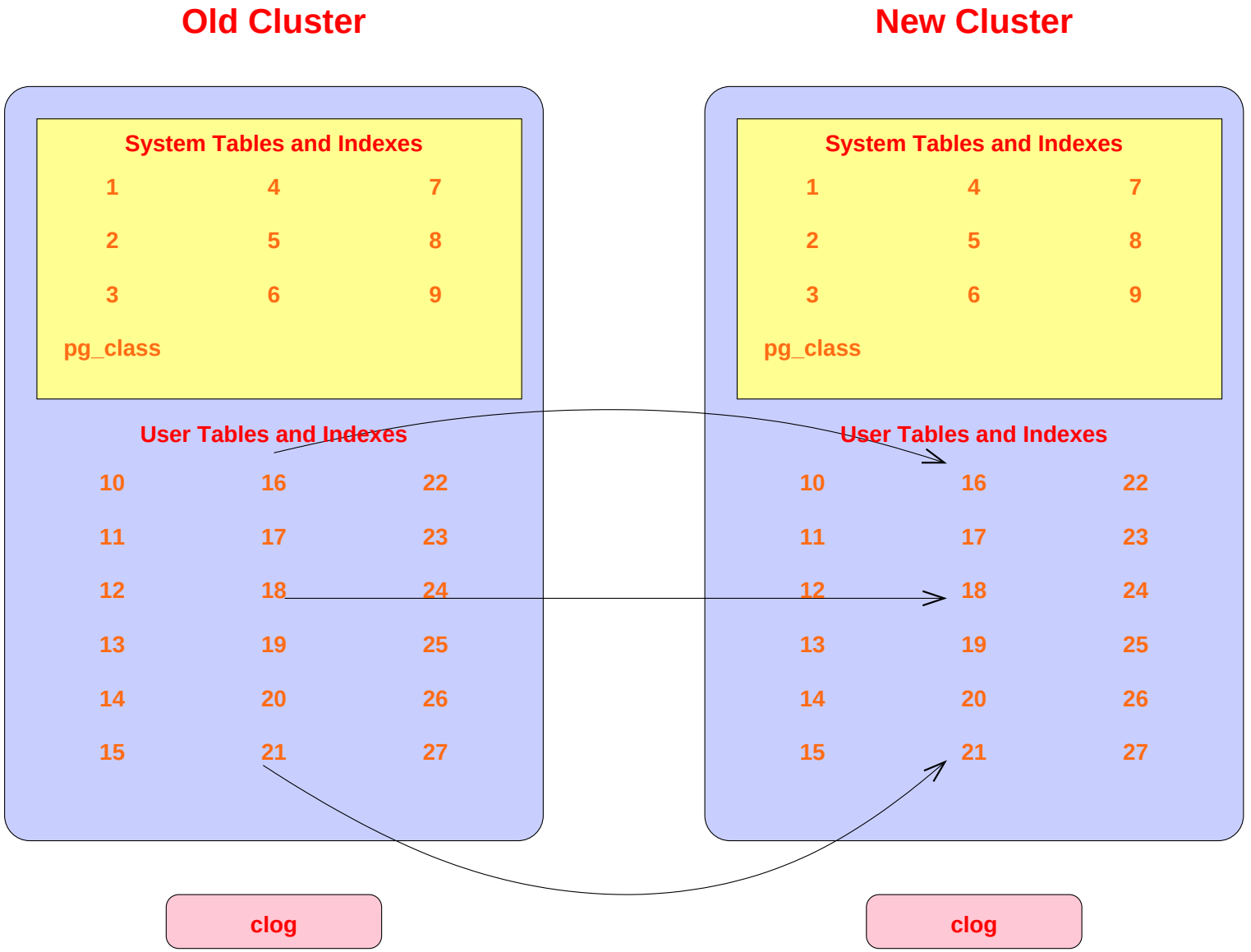
Get Schema Dump



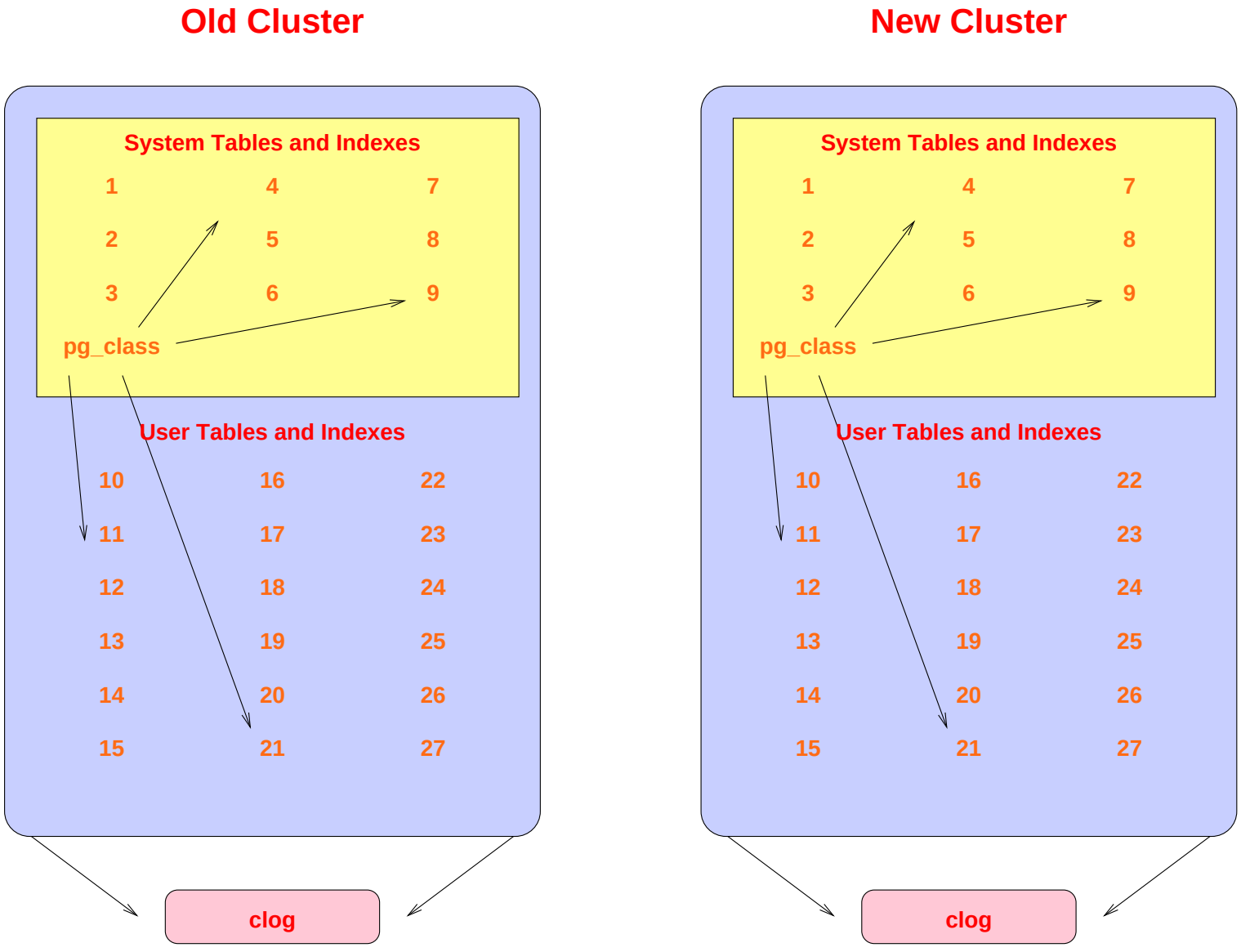
Restore Schema In New Cluster



Copy User Heap/Index Files



Complete


Old Cluster
System Tables and Indexes
1 4 7
2 5 8
3 6 9
pg_class
User Tables and Indexes
10 16 22
11 17 23
12 18 24
13 19 25
14 20 26
15 21 27
clog
New Cluster
System Tables and Indexes
1 4 7
2 5 8
3 6 9
pg_class
User Tables and Indexes
10 16 22
11 17 23
12 18 24
13 19 25
14 20 26
15 21 27
clog

How It Works: In Detail

- Check for cluster compatability
  - 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_clog                             ok
Copying old pg_clog 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.


Linking user relation files
                                                            ok

Setting next OID for new cluster                            ok
```

Sample Run: Completion

```
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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