E-Maj 2.0.1
-
a PostgreSQL extension

French acronym for

Enregistrement des Mises A Jour

i.e. “updates recording"

Components

- E-Maj
  - PostgreSQL extension
  - Open Source (GPL license)
  - Available on
    - pgxn.org
    - github (https://github.com/beaud76/emaj)
- Plug-in for phpPgAdmin 5.1+
  - Available on github (https://github.com/beaud76/emaj_ppa_plugin)
- Documentation source also available on github (https://github.com/beaud76/emaj_doc)

E-Maj objectives

- Record application tables updates in order to:
  - look at them (audit)
  - cancel them if needed
- Usable
  - with applications in test or in production
  - with database of various size

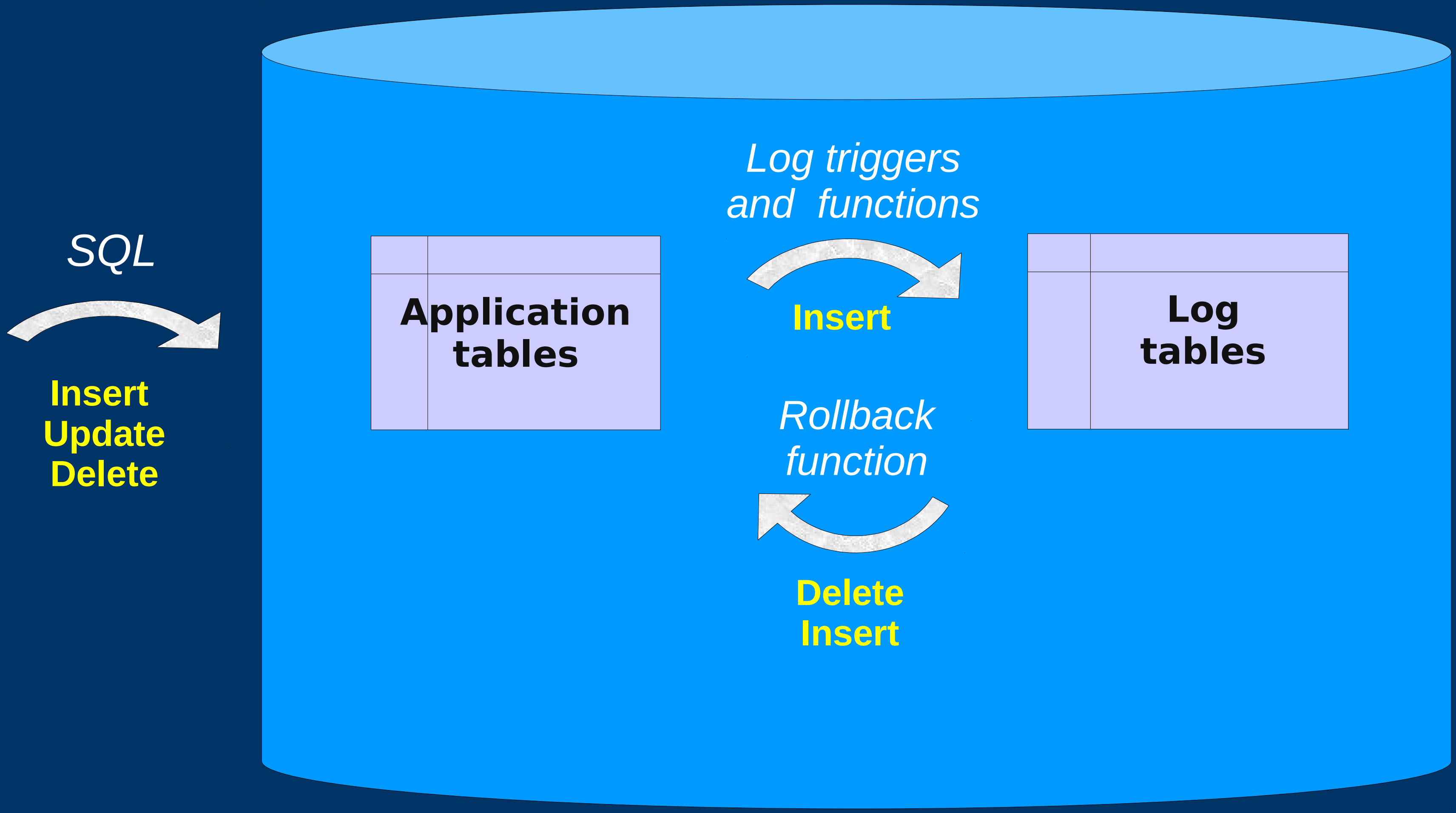
E-Maj Requirements

- Reliability:
  - Absolute integrity of databases after « rollbacks »
  - Manage all usual objects (tables, sequences, constraints,...)
- Ease of use for all users (DBA, production people, application developers and testers,...):
  - Easy to understand and use
  - Easy to integrate into an automatized production (« script-able »)
- Performance:
  - Limited overhead of the log (a few percent)
  - Acceptable « rollback » duration
- Maintainability
- Security

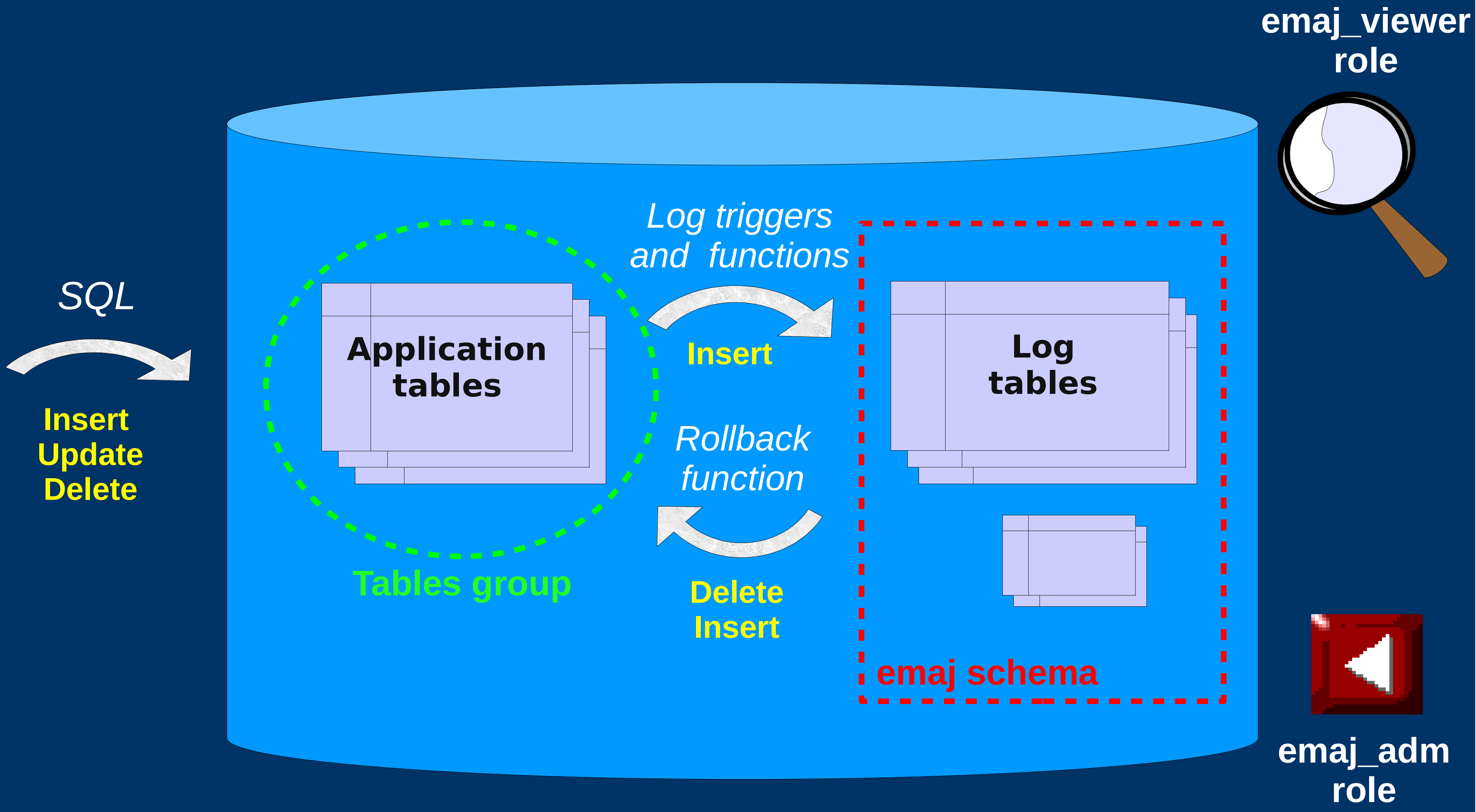
E-Maj Concepts

- Tables group = a set of tables and/or sequences belonging to one or several schemas and having the same life cycle ; it's the only object manipulated by users
- Mark = stable point in the life of a tables group, identified by a name and whose state can be set back
- Rollback = positioning of a tables group at its state when a mark was previously set

The basics of updates logging



E-Maj: general principles



E-Maj Installation

- Download and install the extension in the *share/postgres/extension* directory of the PostgreSQL software
- Copy and adapt the sql/emaj.control file directly into the *share/postgres/extension* directory
- Connect to the targer database as superuser and execute
  - CREATE EXTENSION IF NOT EXISTS DBLINK; (recommended)
  - CREATE EXTENSION EMAJ;
- The installation in the database adds:
  - 1 schema 'emaj' with about 90 functions, 12 technical tables, 7 types, 1 view and 1 sequence
  - 2 event triggers
  - 2 roles

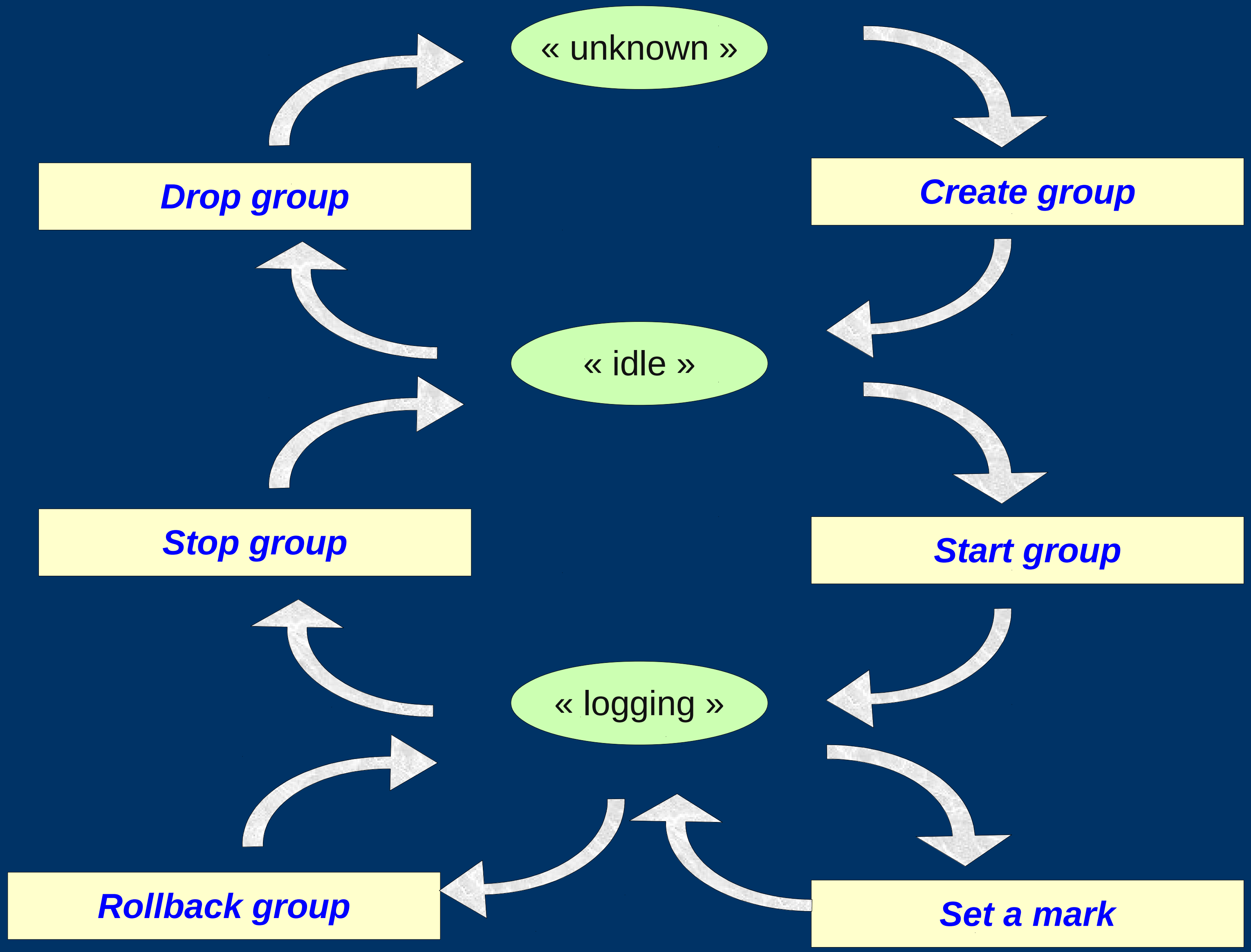
E-Maj Initialisation

- 1) Populate emaj_group_def table to define groups and the tables/sequences they contain
- 2) For each group :
  - SELECT emaj_create_group (group, is_rollbackable);
    => creates for each application table:
    - 1 log table + 1 sequence into an 'emaj' schema
    - 1 trigger + 1 function to log table updates
  - SELECT emaj_drop_group (group)
    … drops a previously created group

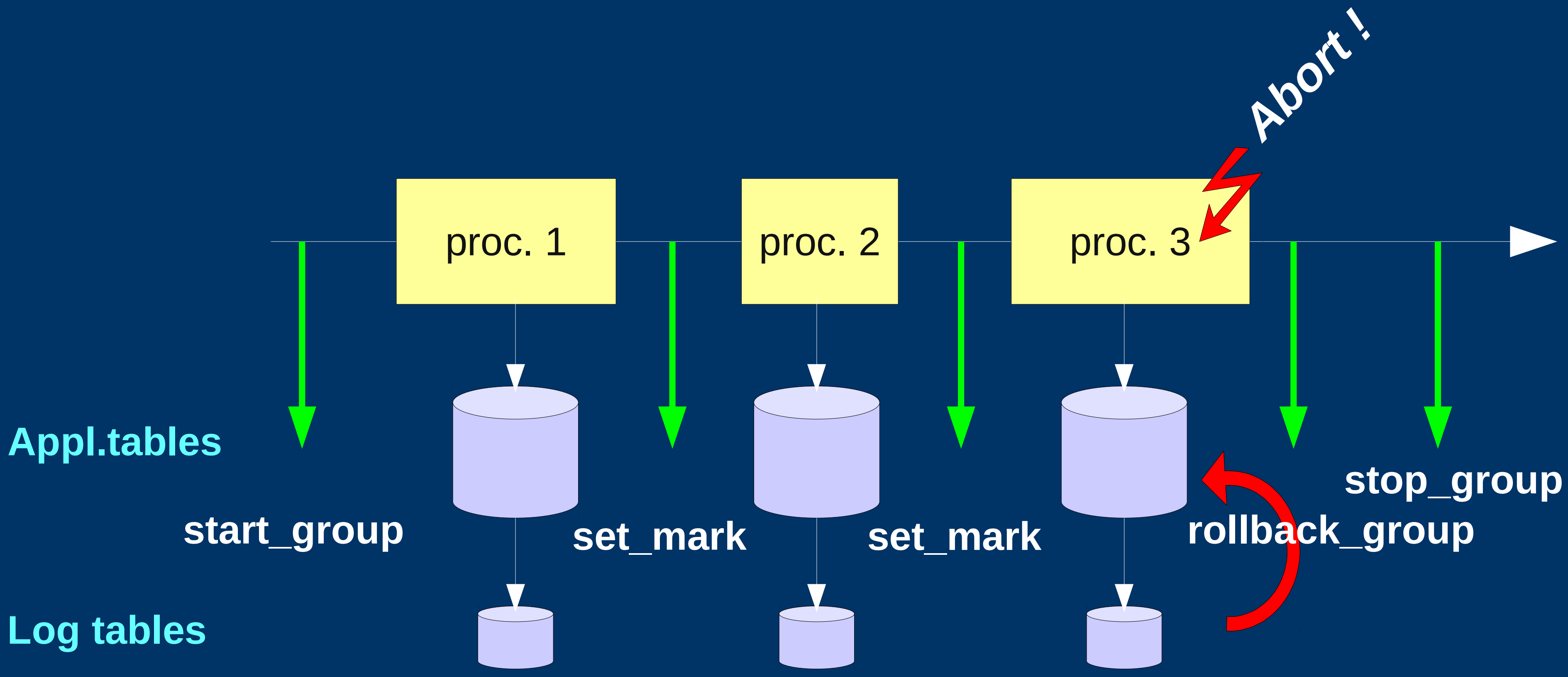
E-Maj: Main functions

- emaj_start_group (group, mark)
  - Activates log triggers and set an initial mark
- emaj_set_mark_group (group, mark)
  - Sets an intermediate mark
- emaj_rollback_group (group, mark)
  - Rollbacks tables and sequences of the group to their state at mark set
- emaj_logged_rollback_group (group, mark)
  - Similar as emaj_rollback_group function but the rollback can be later cancelled (rolled-back!)
- emaj_stop_group (group [,mark])
  - Deactivates log triggers => rollback no longer possible

E-Maj: tables group life cycle



A typical E-Maj sequence ...



Log tables

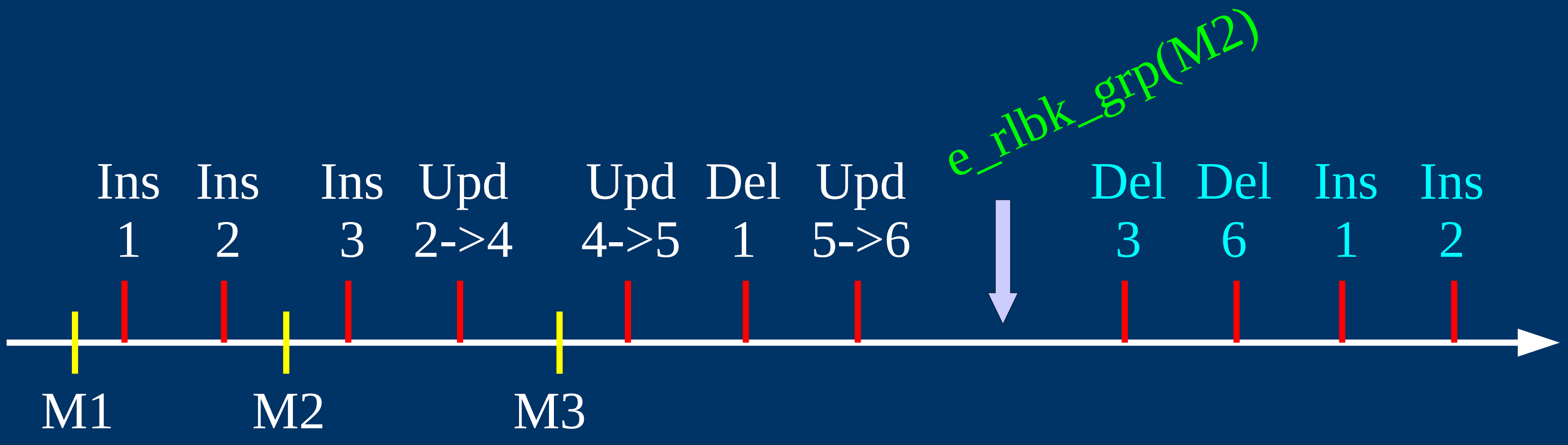
- Examining log tables may largely help application debugging
- A log table contains
  - The same columns as the associated application table
  - And some technical columns
- A changed row in an application table generates
  - 1 log row for an INSERT (new row)
  - 1 log row for a DELETE (old row)
  - 2 log rows for an UPDATE (old and new rows)
- A TRUNCATE generates 1 log row

Technical columns of log tables

- 8 technical columns at the end of each log row
  - emaj_verb : type of change - INS/UPD/DEL/TRU
  - emaj_tuple : type of log row - OLD/NEW
  - emaj_gid : internal sequence number
  - emaj_changed : change timestamp - clock_timestamp()
  - emaj_txid : transaction identifier - txid_current()
  - emaj_user : client connection role - session_user
  - emaj_user_ip : client ip address - inet_client_addr()
  - emaj_user_port : client ip port - inet_client_port()

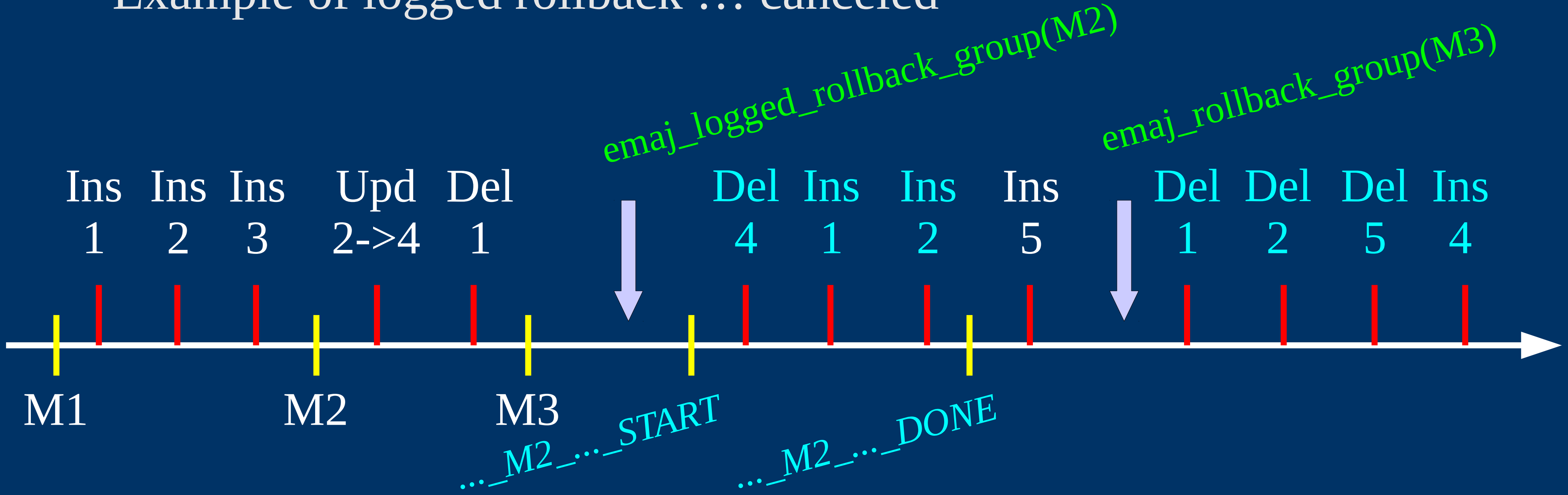
« Simple Rollback »

- Log triggers are de-activated
- Each table is set to its correct state using an optimized algorithm
  - Processes only once each primary key
  - Takes into account potential foreign keys
- Cancelled logs and marks are deleted



« Logged Rollback » (1/2)

- Log triggers are NOT de-activated
- Cancelled logs and marks are kept
- Mark automatically set before and after the rollback
  - RLBK_<marque>_<HH.MI.SS.MS>_START
  - RLBK_<marque>_<HH.MI.SS.MS>_DONE
- Example of logged rollback … canceled



« Logged Rollback » (2/2)

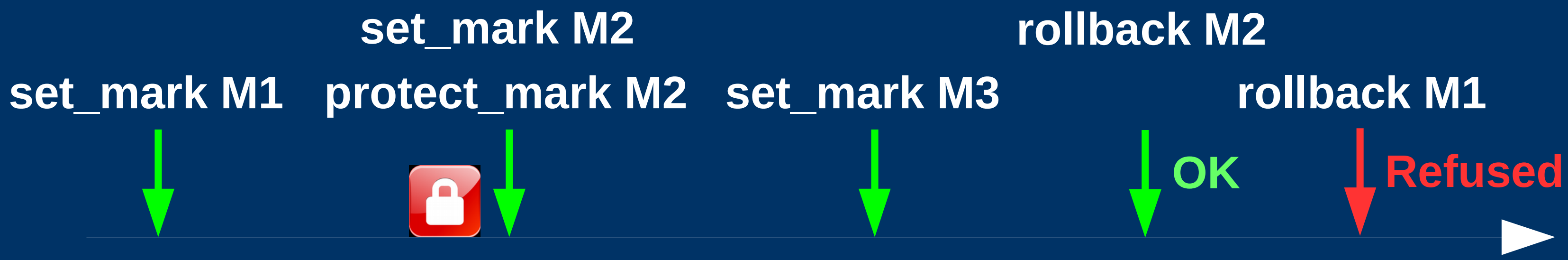
- Ideal for tests : avoid numerous intermediate saves to replay old tests
- During the rollback operation, tables remain accessible for reads
- A logged rollback can be later transformed into a simple rollback => "rollback consolidation"
  - Intermediate logs and marks are deleted, reclaiming log space
  - emaj_consolidate_rollback_group(group, end_rollback_mark)
  - Tables may be updated in parallel

Monitor in progress rollbacks

- Needs dblink, and the setting of the “dblink_user_password” parameter in the emaj_param table
- SELECT * FROM emaj.emaj_rollback_activity();
- Returns
  - Rollback characteristics (group, mark...)
  - Rollback state
  - Elapse time
  - Estimate of the remaining duration and the % done

Protection against accidental rollbacks

- 2 functions to manage the tables group protection
  - emaj_protect_group (group)
  - emaj_unprotect_group (group)
- 2 functions to manage the marks protection
  - emaj_protect_mark_group (group, mark)
  - emaj_unprotect_mark_group (group, mark)



E-Maj possible usages

- Largely helps application tests in providing a way to quickly rollback updates issued by a run and repeat those tests
- In production, provides a rollback capability on batch processing without being obliged to either pg_dump / restore tables or physically save and restore the entire cluster disk space
    - All the more interesting as tables are large, with relatively limited updates

Marks usage strategies (1/2)

- « mono-mark » usage to minimise disk space use
  - repeat
    - start_group (group, mark)
    - processing #i
    - stop_group (group)
- « multi-marks » usage for more flexibility in rollbacks
  - start_group (group, mark1)
  - repeat
    - processing #i
    - emaj_set_mark (group, mark #i+1)
  - stop_group (group)

Marks usage strategies (2/2)

- Permanent logging and regular cancellation of oldest marks (« rolling log »)
  - repeat
    - processing #i
    - emaj_set_mark (group, mark #i+1)
    - emaj_delete_before_mark (group, mark #j)

(warning, marks deletion may be costly if the logs part to erase is important)

Multi-groups functions

- To manage several groups in a single transaction:
  - emaj_start_groups (groups array, mark)
  - emaj_stop_groups (groups array)
  - emaj_set_mark_groups (groups array, mark)
  - emaj_rollback_groups (groups array, mark)
  - emaj_logged_rollback_groups (groups array, mark)
- 2 syntaxes for a groups array
  - ARRAY['group 1','group 2',...]
  - '{"group 1", "group 2",…}'

Marks management functions

- emaj_comment_mark_group (group, mark)
  - Sets, modifies or deletes a comment on a mark
- emaj_rename_mark_group (group, old mark, new mark)
  - Renames a mark
- emaj_delete_mark_group (group, mark)
  - Suppress a mark
- emaj_delete_before_mark_group (group, mark)
  - Suppress all marks preceeding the supplied mark

Other groups management functions

- emaj_comment_group (group, comment)
  - Sets, modifies or deletes a comment on a group
- emaj_reset_group (group)
  - Purges log tables before the next emaj_start_group call (and reclaims disk space)
- emaj_force_stop_group (group)
  - Forces a group stop

Other rollbacks management functions

- emaj_estimate_rollback_group (group, mark)
  - Estimates the time needed to rollback a group to a mark
- emaj_consolidate_rollback_group (group, mark)
  - Consolidate a logged rollback identified by the tables group and the generated end rollback mark. It transforms an unlogged rollback into a logged rollback by deleting all marks and logs between the rollback target mark and the end rollback mark.
- emaj_get_consolidable_rollbacks ()
  - List rollback operations that may be consolidated

Statistic functions

- emaj_log_stat_group (group, begin_mark, end_mark)
  - Quickly provides per table statistics about the number of rows in log tables between 2 marks or between a mark and the current situation
- emaj_detailed_log_stat_group (group, begin_mark, end_mark)
  - Delivers statistics from log tables on updates between 2 marks,
  - Per table, per statement type (INSERT / UPDATE / DELETE) and per ROLE that initiated the updates

Export functions

- emaj_snap_group (group, directory, copy_options)
  - Snaps all tables and sequences of a group on individual files into a directory
- emaj_snap_log_group (group, start_mark, end_mark, directory, copy_options)
  - Snaps part of all log tables and sequences of a group on individual files into a directory
- emaj_gen_sql_group (group, start_mark, end_mark, file_pathname [, tables/seq_list])
  - Generates a sql script replaying updates recorded between 2 marks for all or several tables and sequences of a tables group

Other functions

- emaj_find_previous_mark_group (group, timestamp) or emaj_find_previous_mark_group (group, mark)
  - Retrieves the mark name immediately preceeding a point in time or another mark
- emaj_verify_all ()
  - Verifies the E-Maj environment consistency

For large databases...

- Dedicated tablespaces may be used for log tables and indexes
  - tspemaj tablespace used by default if it exists
  - To use other tablespaces,
    - Create them
    - Configure its use in emaj_group_def table
- Secondary E-Maj schemas may contain log objects
  - To be configured in emaj_group_def table
  - Schemas are created and dropped by E-Maj

Parallel rollback client

- A php module performs parallel restore
- Acts as a client for the database
- Automatically spreads the tables to rollback into a given number of sessions
- Performs the parallel rollback in a unique transaction (➔ max_prepared_transaction >= #sessions)
- emajParallelRollback.php -d <database> -h <host> -p <port> -U <user> -W <password> -g <group_name or groups_list> -m <mark> -s <#sessions> [-l]
- Other options: --help, -v, --version
- Needs php with the PostgreSQL extension

Rollbacks monitoring client

- A php module to monitor in progress or recently completed rollback operations
- emajRollbackMonitor.php -d <database> -h <host> -p <port> -U <user> -W <password> -n <#iterations> -i <refresh_interval_in_seconds> -l <#completed_rollbacks> -a <completed_rollbacks_history_in_hours>
- Other options : --help, -v, --version

```
 E-Maj (version 1.1.0) - Monitoring rollbacks activity
---------------------------------------------------------------

04/07/2013 - 12:07:17
** rollback 35 started at 2013-07-04 12:06:21.474217+02 for groups {myGroup1}
   status: COMMITTED ; ended at 2013-07-04 12:06:21.787615+02
-> rollback 36 started at 2013-07-04 12:04:31.769992+02 for groups {group1232}
   status: EXECUTING ; completion 89 % ; 00:00:20 remaining
-> rollback 37 started at 2013-07-04 12:04:21.894546+02 for groups {group1233}
   status: LOCKING ; completion 0 % ; 00:22:20 remaining
```

Reliability (1/2)

- Many checks, in particular at start_group, set_mark_group and rollback_group times:
  - Do all tables, sequences, functions, triggers exist ?
  - Are we sure that all application tables and their log tables are consistent (columns names and types) ?
- Strong locks on tables at start_group, set_mark_group and rollback_group times to be sure no transaction are currently accessing/updating application tables
- Rollback all tables et sequences in a single transaction

Reliability (2/2)

- TRUNCATE statements are blocked for logging rollbackable groups
- For the most recent PostgreSQL versions (9.3+), some “event triggers” block some unattented component drops or changes (tables, sequences, functions...)
  - 2 functions to disable/re-enable the blocking
    - emaj_disable_protection_by_event_triggers()
    - emaj_enable_protection_by_event_triggers()

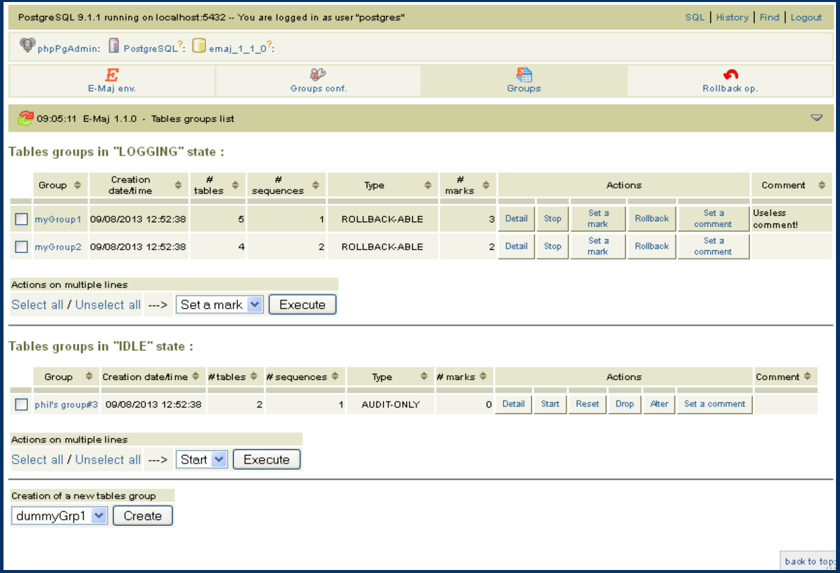
Security

- 2 roles that can be granted :
  - emaj_adm for … E-Maj administration
  - emaj_viewer to just be able to look at E-Maj objects (logs, marks, statistics)
- E-Maj objects are only created by a super-user or a member of emaj_adm
- No other right is granted on the E-Maj schemas, tables and functions
- Log triggers are created as « SECURITY DEFINER »
  - No need to grant extra rights on application tables
- Protection against SQL injections

Performances

- Log overhead
  - Highly depends on hardware and on the application read/write SQL ratio
  - Typically a few % on elapse times
- Rollback duration
  - Highly depends on hardware and database structure (row sizes, indexes, constraints...)

PhpPgAdmin plug-in



PostgreSQL 9.1.1 running on localhost:5432 -- You are logged in as user "postgres" SQL | History | Find | Logout

phpPgAdmin: PostgreSQL?: emaj_1_1_0?:

E-Maj env. | Groups conf. | Groups | Rollback op.

09:05:11 E-Maj 1.1.0 - Tables groups list

Tables groups in "LOGGING" state :

	Group	Creation date/time	# tables	# sequences	Type	# marks	Actions					Comment
☐	myGroup1	09/08/2013 12:52:38	5	1	ROLLBACK-ABLE	3	Detail	Stop	Set a mark	Rollback	Set a comment	Useless comment!
☐	myGroup2	09/08/2013 12:52:38	4	2	ROLLBACK-ABLE	2	Detail	Stop	Set a mark	Rollback	Set a comment	

Actions on multiple lines

Select all / Unselect all ---> Set a mark Execute

Tables groups in "IDLE" state :

	Group	Creation date/time	#tables	# sequences	Type	# marks	Actions						Comment
☐	phil's group#3	09/08/2013 12:52:38	2	1	AUDIT-ONLY	0	Detail	Start	Reset	Drop	Alter	Set a comment	

Actions on multiple lines

Select all / Unselect all ---> Start Execute

Creation of a new tables group

dummyGrp1 Create

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- Fully integrated into phpPgAdmin 5.1+
- Helps administrators and viewers
- Shows all E-Maj objects (groups, marks...) and their attributes
- Allows all possible actions on E-Maj objects
- Justifies by itself the installation of phpPgAdmin

Current limits

- Since E-Maj 2.0.0, the minimum required PostgreSQL version is 9.1
- Every application table belonging to a rollbackable group needs a PRIMARY KEY
- DDL statement cannot be managed by E-Maj

To conclude...

- More information in the documentation + README and CHANGES files
- Many thanks for their help to :
  - Andreas Scherbaum, Jean-Paul Argudo and Dalibo team, CNAF DBAs team, Ronan Dunklau, Don Levine
  - People who already contacted me for comments, requests...
- Feel free to email: phb<dot>emaj<at>free<dot>fr