

# Quality Assurance in PostgreSQL

Anastasia Lubennikova  
Aleksander Alekseev

# Agenda

- Development
- Testing
- Benchmarking
- Tools
- Other Topics

# What is PostgreSQL?

- Open source object-relational database system
- Over 20 years of development
- Hundreds of developers around the world
- Several major vendors



Postgres

PROFESSIONAL

The logo features a stylized, dark blue graphic element that resembles a large, flowing letter 'P' or a stylized 'i' with a dot. This graphic is positioned behind the word 'Postgres' and the word 'PROFESSIONAL'. The word 'Postgres' is written in a large, bold, blue sans-serif font, and 'PROFESSIONAL' is written in a smaller, dark blue, all-caps sans-serif font above it.

# What's so Special About PostgreSQL?

- Pure C
- Complicated project
- Mission critical
- Cross-platform (Windows, Linux, MacOS, Solaris, \*BSD, AIX, HP-UX, ...)
- High code quality
- Great documentation
- Major releases every year

# Development Process

- Git, C, Autotools, Perl
- Mailing Lists
  - [pgsql-hackers@](mailto:pgsql-hackers@)
  - [pgsql-committers@](mailto:pgsql-committers@)
  - [pgsql-bugs@](mailto:pgsql-bugs@)
  - etc
- Conferences
  - [pgcon.org](http://pgcon.org)
  - [pgconf.us](http://pgconf.us)
  - [pgconf.ru](http://pgconf.ru)
  - ... and many more!

# Yes, Mailing Lists

```
1 2 3 47.0 GiB | W: TP-LINK_2.4GHz_B5F0CD 192.168.0.101 | E: down | BAT 57% 05:50 | 0.16 | 2016-08-21 13:47:25 ✖
q:Quit d:Del u:Undel s:Save m:Mail r:Reply g:Group ?:Help
 1 F Apr 06 To Robert Haas (5.5K) >Re: [HACKERS] Yet another small patch - reorderbuffer.c:1099
 2 C Apr 06 Andres Freund (4.0K) >Re: [HACKERS] Yet another small patch - reorderbuffer.c:1099
 3 F Apr 08 To pgsql-hacker (6.3K) [HACKERS] Small patch for snapmgr.c
 4 F Aug 17 To Robert Haas (4.2K) >Re: [HACKERS] [Patch] Temporary tables that do not bloat pg_catalog (a.k.a fast temp tables)
 5 Aug 18 Tomas Vondra (6.4K) >
 6 T Aug 18 Tomas Vondra (5.8K) >Re: [HACKERS] [Patch] Temporary tables that do not bloat pg_catalog (a.k.a fast temp tables)
 7 C Aug 18 Pavel Stehule (7.2K) >
 8 F Aug 17 To Robert Haas (4.8K) Re: [HACKERS] [Patch] RBTREE iteration interface improvement
 9 DF Aug 18 To pgsql-hacker (5.2K) Re: [HACKERS] [Patch] New psql prompt substitution %r (m = master, r = replica)
10 DT Aug 18 Alvaro Herrera (4.1K) >
11 DT Aug 18 Jim Nasby (8.4K) >
12 F Aug 19 To Heikki Linna (13K) >Re: [HACKERS] Re: PROPOSAL: make PostgreSQL sanitizers-friendly (and prevent information discl
13 0 T Aug 19 Andres Freund (2.9K) >
14 0 T Aug 19 Andres Freund (4.5K) >=>
15 0 T Aug 19 Piotr Stefaniak (6.3K) >Re: [HACKERS] Re: PROPOSAL: make PostgreSQL sanitizers-friendly (and prevent information discl
16 0 T Aug 19 Piotr Stefaniak (7.8K) >=>
17 0 C Aug 19 Tom Lane (2.2K) >
18 0 C Aug 19 Tom Lane (3.7K) >=>
19 0 C Aug 19 Piotr Stefaniak (5.1K) >
20 0 C Aug 19 Piotr Stefaniak (6.7K) >=>
21 0 C Aug 19 Andres Freund (2.0K) >
22 0 C Aug 19 Andres Freund (3.5K) >=>
23 0 C Aug 19 Tom Lane (1.4K) >
24 0 C Aug 19 Tom Lane (2.9K) >=>
25 0 C Aug 20 Noah Misch (3.9K) >Re: Re: PROPOSAL: make PostgreSQL sanitizers-friendly (and prevent information disclos
26 0 C Aug 20 Noah Misch (5.4K) >=>[HACKERS] Re: PROPOSAL: make PostgreSQL sanitizers-friendly (and prevent information
27 0 C Aug 20 Tom Lane (3.0K) >Re: [HACKERS] Re: PROPOSAL: make PostgreSQL sanitizers-friendly (and prevent informa
28 0 C Aug 20 Tom Lane (4.5K) >=>
29 N Aug 21 Emre Hasegeli (5.2K) Re: [HACKERS] SP-GiST support for inet datatypes
30 N Aug 21 Thomas Munro (5.5K) Re: [HACKERS] synchronous_commit = remote_flush
```

## pg\_chameleon 1.0 RC1 available now

Posted by [Federico Campoli](#) on 2017-04-16 at 20:19

In 2013 I started my pet project `pg_chameleon` to discharge my frustration only to find the entire thing even more frustrating.

It's fascinating how time and circumstances can fix the personal perspective revamping the passion for development that never left me.

This philosophical introduction is to tell I still can't believe I've relased the RC1 of my pet project [pg\\_chameleon](#).

The release is [already available on pypi](#) and includes several bug fixes and performance improvement. In particular the speed of pulling the row changes from MySQL is now 10 times faster because I'm skipping the implicit BEGIN issued by MySQL when generating a row image.

The display of sources and status is now nicer with the `tabulate` library.

I've also changed the logging file handler to use the time rotate which automatically rotate the replica logs on a daily basis. The log retention is configurable using the parameter `log_days_keep`.

It's also present a new command `detach_replica` which creates a standalone postgresql database with the sequences correctly set and the foreign keys created as invalid. The detach process tries to validate the foreign keys in a second moment though.

Pypi: [https://pypi.python.org/pypi/pg\\_chameleon/](https://pypi.python.org/pypi/pg_chameleon/)  
Documentation: [http://pythonhosted.org/pg\\_chameleon/](http://pythonhosted.org/pg_chameleon/)  
Github: [https://github.com/the4thdoctor/pg\\_chameleon](https://github.com/the4thdoctor/pg_chameleon)

From this release I won't add new features but I'll focus only on bug fixes.

### Changelog from v1.0 beta 2.

- add support for primay key defined as column constraint
- fix regression if null constraint is omitted in a primary key column
- add foreign key generation to detach replica. keys are added invalid and a validation attempt is performed.
- add support for truncate table
- add parameter `out_dir` to set the output destination for the csv files during `init_replica`
- add set `tables_only` to `table_limit` when streaming the mysql replica
- force a close batch on rotate event if binlog changes without any row events collected
- fixed replica regression with python 3.x and empty binary data
- added `event_update` in `hexli`

[...]

## Top posters

Number of posts in the past month

-  [Bruce Momjian](#) (EnterpriseDB) - 22
-  [Hubert 'depesz' Lubaczewski](#) - 9
-  [Joshua Drake](#) - 7
-  [Shaun M. Thomas](#) - 7
-  [Oleg Bartunov](#) (Postgres Professional) - 7
-  [Alexey Lesovsky](#) (PostgreSQL-Consulting) - 6
-  [Craig Ringer](#) (2ndQuadrant) - 3
-  [Kaarel Moppel](#) (Cybertec) - 3
-  [Federico Campoli](#) - 3
-  [Pavel Stehule](#) - 3

## Top teams

Number of posts in the past month

- [EnterpriseDB](#) - 26
- [2ndQuadrant](#) - 10
- [Postgres Professional](#) - 9
- [OpenSCG](#) - 7
- [PostgreSQL-Consulting](#) - 6
- [pgExperts](#) - 5
- [Crunchy Data](#) - 4
- [Cybertec](#) - 4
- [PostGIS](#) - 3
- [credativ](#) - 3

## Feeds

-  [All feeds \(full entries\)](#)
-  [All feeds \(short entries\)](#)

## Planet

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## Welcome to the PostgreSQL Wiki!

This wiki contains user documentation, how-tos, and tips 'n' tricks related to PostgreSQL. It also serves as a collaboration area for PostgreSQL contributors.

### User Documentation

- [Frequently Asked Questions](#)

### Community Generated Articles, Guides, and Documentation

- [General articles and guides](#)
- [PostgreSQL Tutorials](#)
- [PostgreSQL Related Code Snippets](#)
- [Detailed installation guides](#)
- [Converting from other Databases to PostgreSQL](#)
- [Comparison with other Database systems](#)
- [Database Administration and Maintenance](#)
- [Development with PostgreSQL](#)
- [PostgreSQL Performance Optimization](#)
- [PostgreSQL Related Slides and Presentations](#)

### Documentation on the main site

- [PostgreSQL Manuals](#) 
- [PostgreSQL Books](#) 

### Alternate Languages

The following pages contain user documentation in languages other than English.



#### navigation

- [Main Page](#)
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#### search

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# Commitfest 2017-03

Search/filter

Shortcuts ▾

**Status summary:** Committed: 116. Moved to next CF: 51. Rejected: 2. Returned with Feedback: 40. Total: 209.

## Closed patches

	Status	Author	Reviewers	Committer	Latest activity	Latest mail
<b>Bug Fixes</b>						
Fix the optimization to skip WAL-logging on table created in same transaction	Moved to next CF	Heikki Linnakangas (heikki), Michael Paquier (michael-kun)	Michael Paquier (michael-kun), Kyotaro Horiguchi (horiguti)	alvherre	2017-04-08 13:54	2017-04-13 09:42
pgwin32_is_service not checking if SECURITY_SERVICE_SID is disabled	Committed	Michael Paquier (michael-kun), Takayuki Tsunakawa (maumau)	Takayuki Tsunakawa (maumau)	heikki	2017-03-17 09:19	2017-03-17 09:19
Floating point comparison inconsistencies of the geometric types	Returned with feedback	Emre Hasegeli (hasegeli)	Kyotaro Horiguchi (horiguti), Kevin Grittner (kgrittn)		2017-03-16 16:10	2017-03-16 16:10
Failure at replay for corrupted 2PC files + reduce window between end-of-recovery record and history file write	Moved to next CF	Heikki Linnakangas (heikki), Michael Paquier (michael-kun)	Alexander Korotkov (smagen), Takayuki Tsunakawa (maumau)		2017-04-08 14:03	2017-04-08 14:05
Potential data loss with 2PC files and unlink() durability	Committed	Michael Paquier (michael-kun)	Fedor Sigaev (sigaev), Takayuki Tsunakawa (maumau), Ashutosh Bapat (ashutoshbapat)	sigaev	2017-03-27 16:33	2017-03-28 01:36
replace broken GetExistingLocalJoinPath with CreateLocalJoinPath	Moved to next CF	Etsuro Fujita (efujita)	Robert Haas (rhaas), Ashutosh Bapat (ashutoshbapat)		2017-04-08 13:58	2017-04-11 09:13
Allow index-only scans to return tuples larger than one page	Committed	Tom Lane (tgl)	jason li (jasonysli)	tgl	2017-02-27 22:22	2017-01-04 00:21
Subtle bug in "Simplify tape block format" commit	Committed	Peter Geoghegan (pgeoghegan)		heikki	2017-02-02 18:58	2017-02-01 10:18
Incorrect XLogRegisterBuffer flag for revmapbuf in brin	Committed	KUNTAL GHOSH (kuntal_ghosh)	Michael Paquier (michael-kun)	alvherre	2017-01-09	2017-01-10

# Submitting a Patch

- Optional: Proposal and discussion
- Optional: PoC
- Patch is added to commitfest
- While(not ready):
  - Code review
  - Testing
  - Discussion
  - More discussion
  - Rewrite a patch
- Either:
  - Patch is accepted
  - Patch is moved to the next commitfest
  - Patch is returned with a feedback



## PostgreSQL BuildFarm Status

Shown here is the latest status of each farm member for each branch it has reported on in the last 30 days.

Use the farm member link for history of that member on the relevant branch.

Legend	= cassert	= debug	= disable-integer-datetimes	= gssapi	= krb5	= nls	= openssl
	= pam	= perl	= python	[tcl] = tcl	= thread-safety	= vpath	= xml

Branch: HEAD				
Alias	System	Status	Flags	
culicidae	Debian sid gcc 6.3 x86-64	00:24:32 ago OK [b6dd127] Config	[tcl]	
bowerbird	Windows 8 8.1 Pro Visual Studio 2012 x86_64	00:53:11 ago OK [b6dd127] Config		
damselfly	illumos (SmartOS) joyent_20131120T074720Z gcc 4.7.3 x86_64	00:56:06 ago OK [b6dd127] Config	[tcl]	
loach	FreeBSD 10.3-RELEASE clang 3.4.1 x86_64	01:09:33 ago OK [b6dd127] Config	[tcl]	
broлга	Cygwin/XP-Pro 1.7.7 gcc 4.3.4 i386	01:35:01 ago OK [b6dd127] Config		
lorikeet	Cygwin64/Win8.1Pro 2.0.4-1 gcc 4.9.3 x86_64	02:01:39 ago OK [b6dd127] Config		
sprat	RedHat Enterprise Linux 7 7.2 GCC 4.8.5 s390x	02:38:54 ago OK [b6dd127] Config	[tcl]	
grouse	RedHat Enterprise Linux 6 6.5 gcc 4.4.7 s390	02:39:33 ago OK [b6dd127] Config	[tcl]	
nudibranch	SUSE Linux Enterprise Server 11 gcc 4.3.4 s390	02:42:50 ago OK [b6dd127] Config	[tcl]	
chipmunk	Raspbian GNU/Linux 7.0 gcc 4.6.3 armv6l	02:54:33 ago OK [b6dd127] Config	[tcl]	
quokka	RHEL 7.2 IBM Advance Toolchain GCC 5.2.1 (Advance-Toolchain-at9.0) ppc64	03:24:26 ago OK [b6dd127] Config	[tcl]	
mule	Debian 8.1 gcc 4.9.2 amd64	03:54:32 ago OK [b6dd127] Config	[tcl]	
koreaceratops	CentOS Linux 6.6 (Final) gcc 4.4.7 x86_64	04:01:07 ago OK [b6dd127] Config	[tcl]	
gharial	HP-UX B.11.31 U gcc 4.6.0 ia64	04:02:43 ago OK [b6dd127] Config		
mandrill	AIX 7100-03-02-1412 xlc 12.1 (32 bit) ppc64 (POWER7)	04:35:32 ago OK [b6dd127] Config	[tcl]	
hornet	AIX 7100-03-02-1412 xlc 12.1 (64 bit) ppc64 (POWER7)	04:42:53 ago OK [b6dd127] Config		
sungazer	AIX 7100-03-02-1412 gcc 4.8.1 (64 bit) ppc64 (POWER7)	04:49:56 ago OK [b6dd127] Config		
sidewinder	NetBSD 7 gcc 4.8.4 x86_64	05:39:33 ago OK [b6dd127] Config	[tcl]	
curculio	OpenBSD 5.9 gcc 4.2.1 x86_64	05:54:32 ago OK [b6dd127] Config	[tcl]	

# What to test?

- Modular\* tests
  - Indexes
  - Replication
  - Types
  - WAL / Recovery
- Integration/system tests
  - How various features work together?
  - Upgrade, Backup/Restore, etc
- Performance
  - Previous versions
  - Other implementations
- Documentation (SGML)
- Alpha and beta tests

# How to test?

- Code review
- Regular SQL input / output tests
  - Can't test utilities, concurrency, etc..
  - Must be deterministic
  - Should be executed to see the exact output
- TAP/Perl tests
  - SSL
  - Replication and recovery
- pgTAP framework
- Testgres - python framework

# Benchmarks

- Industry standard benchmarks
  - TPC-H
  - TPC-E
  - TPC-B
- Pgbench

# Basic Tools

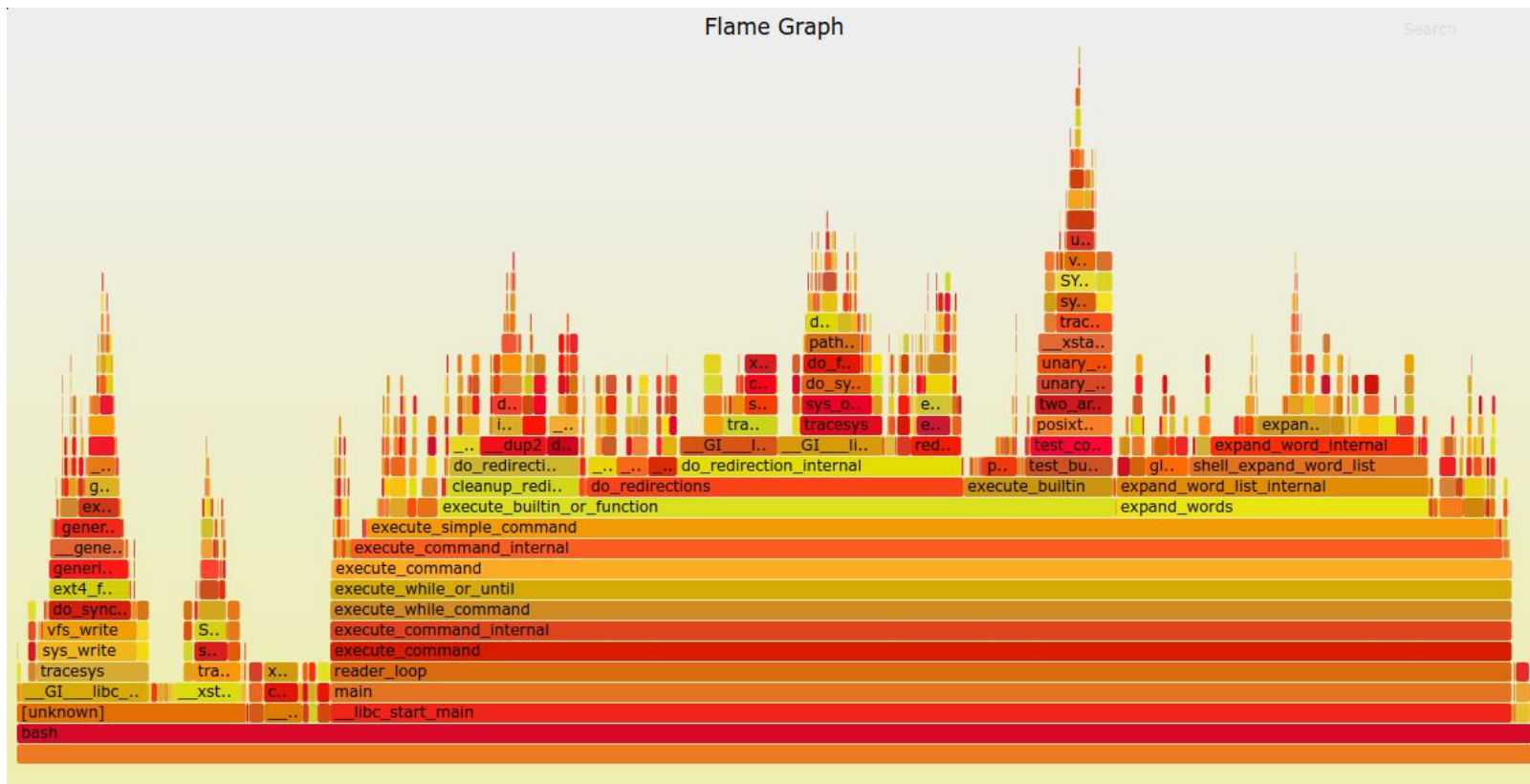
- gcc / clang / ...
- gdb / lldb
- vim + `:set spell spelllang=en_us,ru_ru`
- Asserts
- `wal_consistency_checking = 'all'`
- `log_level = DEBUG`
- amcheck (property based tests)
- sqlsmith (fuzzing)
- valgrind



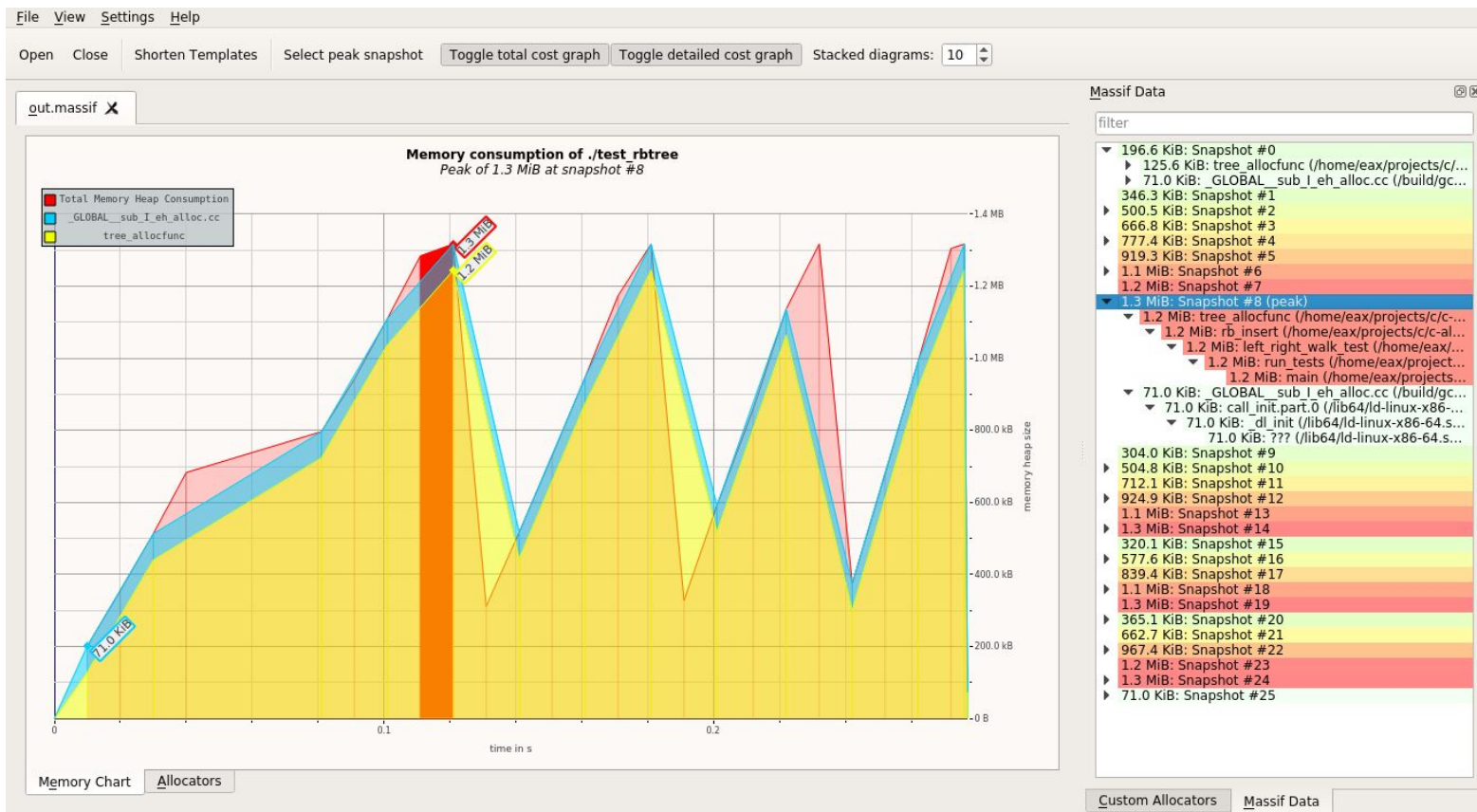
# Perf: perf top

```
Samples: 66K of event 'cycles:ppp', Event count (approx.): 160992
Overhead  Symbol
34.74%    [.] get_tabstat_entry
30.14%    [.] find_all_inheritors
 5.82%    [.] SearchCatCache
 5.53%    [.] AllocSetCheck
 3.02%    [.] heap_getsysattr
 2.31%    [.] GrantLock
 1.53%    [.] AllocSetAlloc
 1.44%    [.] strlen@plt
 1.20%    [.] eval_const_expressions_mutator
 0.98%    [.] sentinel_ok
 0.93%    [.] ResourceArrayRemove
 0.82%    [.] bms_is_empty
 0.82%    [.] MemoryContextCreate
 0.82%    [.] estimate_rel_size
 0.69%    [.] translate_col_privs
 0.65%    [.] check_stack_depth
 0.63%    [.] stack_is_too_deep
 0.55%    [.] set_sentinel
 0.55%    [.] make_inh_translation_list
 0.55%    [.] list_length
 0.48%    [.] hash_uint32
 0.48%    [.] find_inheritance_children
 0.32%    [.] pg_qsort
```

# Perf: flamegraphs



# HeapTrack + Massif Visualizer



# lcov [ 1 / 2 ]




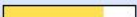









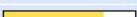








## LCOV - code coverage report

Current view: [top level](#)

Test: [unnamed](#)

Date: 2017-04-17 15:42:54

	Hit	Total	Coverage
Lines:	274110	380958	72.0 %
Functions:	16666	20579	81.0 %

Directory	Line Coverage ↕			Functions ↕	
<a href="#">/usr/include/arpa</a>		100.0 %	2 / 2	100.0 %	2 / 2
<a href="#">/usr/lib/gcc/x86_64-pc-linux-gnu/6.3.1/include</a>		85.7 %	12 / 14	100.0 %	2 / 2
<a href="#">/usr/lib/perl5/core_perl/CORE</a>		77.8 %	7 / 9	50.0 %	1 / 2
<a href="#">contrib/amcheck</a>		76.3 %	171 / 224	100.0 %	17 / 17
<a href="#">contrib/bloom</a>		90.8 %	464 / 511	96.7 %	29 / 30
<a href="#">contrib/btree_gin</a>		94.1 %	160 / 170	100.0 %	175 / 175
<a href="#">contrib/btree_gist</a>		96.4 %	1999 / 2074	98.6 %	500 / 507
<a href="#">contrib/citext</a>		92.5 %	86 / 93	95.5 %	21 / 22
<a href="#">contrib/cube</a>		72.8 %	970 / 1332	81.2 %	108 / 133
<a href="#">contrib/dblink</a>		86.8 %	941 / 1084	97.4 %	74 / 76
<a href="#">contrib/dict_int</a>		73.3 %	22 / 30	100.0 %	5 / 5
<a href="#">contrib/dict_xsyn</a>		96.2 %	100 / 104	100.0 %	8 / 8
<a href="#">contrib/earthdistance</a>		90.9 %	20 / 22	100.0 %	5 / 5
<a href="#">contrib/file_fdw</a>		76.0 %	237 / 312	90.9 %	20 / 22
<a href="#">contrib/hstore</a>		82.8 %	1367 / 1650	75.2 %	118 / 157
<a href="#">contrib/hstore_plperl</a>		100.0 %	51 / 51	100.0 %	6 / 6
<a href="#">contrib/hstore_plpython</a>		93.9 %	62 / 66	100.0 %	6 / 6
<a href="#">contrib/intarray</a>		84.7 %	1182 / 1395	90.3 %	130 / 144
<a href="#">contrib/isn</a>		82.9 %	368 / 444	88.6 %	39 / 44
<a href="#">contrib/ltree</a>		88.6 %	1690 / 1907	92.3 %	155 / 168
<a href="#">contrib/ltree_plpython</a>		100.0 %	15 / 15	100.0 %	4 / 4
<a href="#">contrib/pageinspect</a>		80.4 %	752 / 935	96.5 %	55 / 57

# lcov [ 2 / 2 ]

```
37 : /*
38 : char *
39 21 : get_role_password(const char *role, char **logdetail)
40 : {
41 21 :     TimestampTz vuntil = 0;
42 :     HeapTuple   roleTup;
43 :     Datum       datum;
44 :     bool        isnull;
45 :     char        *shadow_pass;
46 :
47 :     /* Get role info from pg_authid */
48 21 :     roleTup = SearchSysCache1(AUTHNAME, PointerGetDatum(role));
49 21 :     if (!HeapTupleIsValid(roleTup))
50 :     {
51 0 :         *logdetail = psprintf( ("Role \"%s\" does not exist."),
52 :                                role);
53 0 :         return NULL; /* no such user */
54 :     }
55 :
56 21 :     datum = SysCacheGetAttr(AUTHNAME, roleTup,
57 :                             Anum_pg_authid_rolpassword, &isnull);
58 21 :     if (isnull)
59 :     {
60 0 :         ReleaseSysCache(roleTup);
61 0 :         *logdetail = psprintf( ("User \"%s\" has no password assigned."),
62 :                                role);
63 0 :         return NULL; /* user has no password */
64 :     }
65 21 :     shadow_pass = TextDatumGetCString(datum);
66 :
67 21 :     datum = SysCacheGetAttr(AUTHNAME, roleTup,
68 :                             Anum_pg_authid_rolvaliduntil, &isnull);
69 21 :     if (!isnull)
70 0 :         vuntil = DatumGetTimestampTz(datum);
71 :
72 21 :     ReleaseSysCache(roleTup);
73 :
74 21 :     if (*shadow_pass == '\0')
75 :     {
76 0 :         *logdetail = psprintf( ("User \"%s\" has an empty password."),
77 :                                role);
78 0 :         pfree(shadow_pass);
79 0 :         return NULL; /* empty password */
80 :     }
```

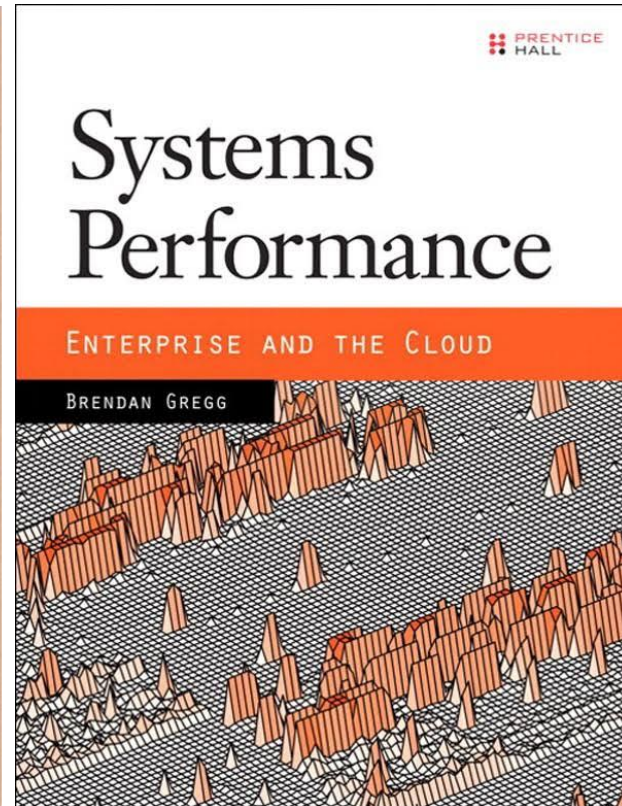
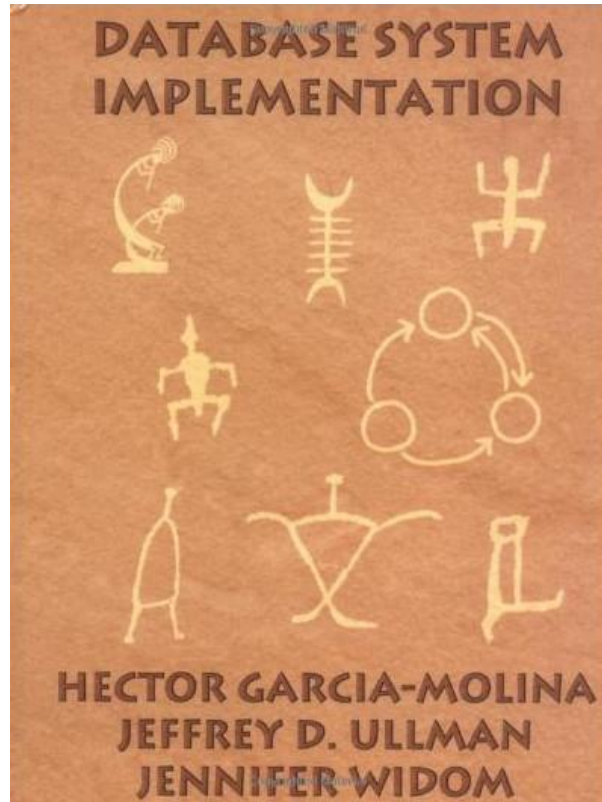


# Clang Static Analyzer

```
864  /*
865  *      mdnblocks() -- Get the number of blocks stored in a relation.
866  *
867  *      Important side effect: all active segments of the relation are opened
868  *      and added to the mdfd_seg_fds array. If this routine has not been
869  *      called, then only segments up to the last one actually touched
870  *      are present in the array.
871  */
872  BlockNumber
873  mdnblocks(SMgrRelation reln, ForkNumber forknum)
874  {
875      MdfdVec      *v = mdopen(reln, forknum, EXTENSION_FAIL);
876
877      BlockNumber nblocks;
878      BlockNumber segno = 0;
879
880      /* mdopen has opened the first segment */
881      Assert(reln->md_num_open_segs[forknum] > 0);
```

Value stored to 'v' during its initialization is never read

# Books



# Links

- <https://www.postgresql.org/>
- <http://postgres-edu.blogspot.ru/search/label/Hacking%20PostgreSQL>
- <https://github.com/afiskon/pgscripts>
- <https://habr.ru/p/308442/> + related articles



Thank you for your attention!

- <https://postgrespro.com/> (We are hiring! ;)
- [a.lubennikova@postgrespro.ru](mailto:a.lubennikova@postgrespro.ru)
- [a.alekseev@postgrespro.ru](mailto:a.alekseev@postgrespro.ru)